A UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

MARINERS WEATHER Log

VOLUME 17, NUMBER 2

MARCH 1973

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL DATA SERVICE

DEPARTMENT OF COMMERCE
RICK B. DENT, SECRETARY

NAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ERT M. WHITE, ADMINISTRATOR

VIRONMENTAL DATA SERVICE
AS S. AUSTIN, DIRECTOR

MARINERS WEATHER LOG

ELWYN E. WILSON, EDITOR

DONNA J. GRANT
EDITORIAL ASSISTANT

MARCH 1973
VOLUME 17, NUMBER 2
WASHINGTON, D.C.

Cover: Storm takes cottage--a cottage collapsed under the pounding of waves in the Lake Erie storm of November 14. The effects of the storm were heightened by the high water levels on the Lake. For details on this damaging Great Lakes storm see the article titled "Fall Storm and High Lake Levels Spell Disaster Around the Great Lakes" on page 66. Wide World Photo.

Routing
Master
Observing Officers

Radio Officer

PARTICIPATE IN AMVER

PLEASE PASS THIS ISSUE ALONG

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1973.

Copies available to persons or agencies with a marine interest from the Environmental Data Service, Page Bldg. 2 (D54), 3300 Whitehaven St., Washington, D.C. 20235.

MARINERS WEATHER Log

ABNORMAL WAVE ACTION WITHIN HARBORS

R. W. James
U.S. Naval Oceanographic Office
Washington, D.C.

Harbors are designed to provide a ship berthing area as free as possible from any significant wave action. Many ports are so well protected, by natural configuration or through the construction of breakwaters, that only local chop of negligible height is present during loading or unloading operations. At times, however, even in well-protected harbors, waves of a special nature occur which can produce ship motions disruptive to loading. On occasion, these motions are severe enough to lead to snapped hawsers, damaged piers, or stoved-in hulls. There are many environmental forces that produce minor movement of a berthed ship such as local chop, tides, wind, and currents. What is involved in these larger ship motions are abnormal wave actions such as seiches, tsunamis, and long-period swells.

A disarming characteristic of abnormal waves is their occurrence under the best of local weather conditions. A ship may be off-loading under fair skies and light winds with no perceptible motion. The first hint of the onset of abnormal wave action is a slight longitudinal movement. This motion increases over the next hour or two to the point where loading operations are cancelled, or when damage is incurred.

Seiche, or harbor surge, is simple wave motion similar to that observed in a wash basin that is sud-

Figure 1.--The refraction and reflection of long swells, originating thousands of miles away in the South Pacific Ocean, can halt ship operations because of excessive horizontal ship motion in Acajutla Harbor, El Salvador.

denly tilted, then leveled again. The water motion in a harbor is not due to tilting, of course, but to some disturbance in the vicinity of the harbor which starts the water to oscillate. Water within any natural basin such as a lake, bay, or harbor has certain natural periods of vibration depending upon the shape and depth of the water feature. Any number of actions can initiate a seiche, an increasing or shifting wind, passage of a meteorological front, for instance, but most seiches are produced by the arrival of long-period waves.

A seiche is characterized by vertical motions at the ends of the harbor (basin) and only horizontal motion at the center or nodal point. Thus, depending upon its location within a harbor, a ship may experience either vertical on horizontal displacements. For harbors with a wide entrance to the sea rather than an enclosed bay, the seiche is more complicated with several nodes. This rhythmic sloshing of water back and forth within a harbor can, of course, exert a tremendous force on a moored ship.

The time period between successive oscillations of a seiche usually varies between 2 and 40 min, with large, shallow harbors having the longer periods and deep, small harbors the shorter. Seiches are often difficult to observe visually since the surface water is not rippled or disturbed as with shorter waves, but the resulting ship motion is readily apparent.

Not all harbors have detectable seiches. Locations that are exposed to frequent trains of long-period waves (swell or tsunamis) are more apt to experience seiches. This is true of the Pacific coasts in the Western Hemisphere; harbors in California, and the west coasts of Central and South America are where seiches have been reported.

A particular problem with seiches has been found in Los Angeles harbor. Large ships have snapped mooring lines and broken pilings because of horizontal movements of the ship caused by a seiche. The damage occurs when ships move longitudinally up to 10 ft with periods of 1 to 3 min, although the vertical amplitudes of the seiche may be only 0.2 ft in height. On one occasion, the swell present in the area, which was supposedly the initiating disturbance, was only 1 ft in height, with a period of 15 sec.

In addition to long-period swell, another wave phenomenon that may excite harbor waters into a seiche motion is a tsunami. These waves, sometimes erroneously called tidal waves, can reach tremendous heights (50 to 100 ft), but such an occurrence is rare even in areas known for tsunamis. In most cases there is only a slight change in sea level (1 to 3 ft) over a period of 10 to 15 min. Tsunamis are so long, with wavelengths measured in miles, that they are imperceptible to ships at sea. When these waves reach shallow water, however, their wavelength shortens and their height increases as bottom friction and coastal configuration transforms the low waves into larger, possibly damaging waves.

Tsunamis are not uncommon; however, the majority are insignificant in height even in shallow water and go unnoticed by the casual observer, although their presence is revealed through perturbations in tidal records. They are produced by seismic actions such as earthquakes, in which vertical masses of water are suddenly lifted or dropped as the sea bottom heaves or sinks. The resulting wave action is similar to the concentric wave trains generated by a pebble dropped in a pond, although on a much larger scale.

A large earth movement, such as that recorded at Prince William Sound, Alaska, in 1964, can produce a tsunami with damaging wave action. On that occasion, a tsunami hit Kodiak with waves of 35 ft and 2 hr later, a 12-ft wave swept into Crescent City, Calif., destroying much of the waterfront. Tsunamis may have indirect effects also, since many minor earth movements may trigger tsunamis too small to bother a harbor directly, but of sufficient strength and frequency to initiate a seiche.

One of the more favorable aspects of a tsunami is that they are somewhat predictable, since a tsunami is probable whenever an earthquake is located by a seismograph network as occurring under the sea. As with seiches, the Pacific Ocean is the area one is most likely to encounter tsunamis. This is because a zone of extreme seismic activity encircles the Pacific Ocean. Accordingly, a seismic sea-wave warning system has been established in the Pacific by NOAA, linking countries that have experienced tsunamis in the past.

The third, and most common source of adverse ship motions in a harbor, is long-period swell. As with tsunamis, these waves may generate ship motions directly or may act indirectly through excitation of the harbor waters to cause ship loading problems. It is obvious that heavy swell, oriented to enter a harbor unimpeded, can produce adverse ship motions and disrupt ship operations. What is not obvious, but is not uncommon, is that swell may find its way into harbors seemingly well protected in the direction of the approaching swell.

An example of this is given by the nature of wave motions at Acajutla Harbor in El Salvador. Acajutla is the major port for El Salvador and consists of an L-shaped breakwater with an inner pier as shown in figure 1. Ships utilizing this harbor experience excessive horizontal motions at times, with complete disruption of off-loading or loading operations. On occasion, these motions become sufficiently violent to damage large fenders on the pier, snap hawsers or incur damage to the ship. This may require a ship to depart the harbor for deeper water until the phenomenon ceases. These unusual motions occur with little warning and may persist from 12 hr up to 3 days.

The nature of the ship motions suggests either a seiche or long-period swell, but the period of the ship motions, as reported by the port engineer, was too short for a seiche. Swell arrives on the coast of El Salvador from storms in the Southern Hemisphere which generate waves of 20 to 40 ft in height. Figure 2 shows a typical storm during winter months. Although reduced by decay to 20 percent of their original height, these waves arrive days later off the coast with periods of 12 to 20 sec and sufficient energy to move large ships. Since these storms move eastward across the South Pacific Ocean, the swell is propagated in a wide swath over the life of the storm, which may include coasts from California to Cape Horn. This long-period swell approaches Acajutla from the southwest and is blocked from entering the harbor directly by the outer pier, which is a breakwater. Two separate but related phenomena act to introduce the wave motion into the berthing area: wave refraction and wave reflection.

Wave refraction is the bending of wave crests as they approach a coast at an angle to the bottom contours. Waves slow down in shallow water, because of

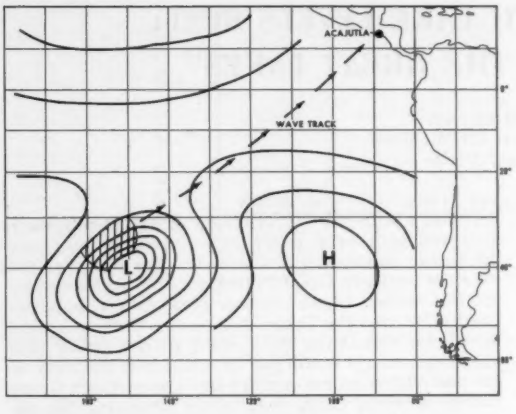

Figure 2. --Typical Southern Hemisphere storm with resulting wave track.

bottom friction, so the part of the wave closer to the beach moves slower than the part in deeper water. This variation in wave speed eventually causes the wave crests to parallel the bottom contours.

The result of wave refraction at Acajutla, is to bring the southwest swell onto the beach much closer to the shoreward end of the pier than if it had proceeded directly to the beach on a straight line. This action is illustrated in figure 3.

As a consequence of the above action, the long-period swell strikes the coast at the very point where rocky headlands occur, and, instead of dissipating on a beach, the waves are reflected. Short choppy waves, or breaking waves, lose much of their energy when encountering a vertical surface, but long, low swell simply rises up the cliff face, then reflects back with almost no loss in energy. As can be seen from figure 3, the refraction causes the swell to approach the cliffs at just the angle of incidence to reflect wave energy directly into the berthing area. Here, with little decrease of the original wave energy, the reflected swell disrupts ship operations. At times, the water in the harbor may appear completely smooth, yet a ship at the pier will oscillate over a 5- to 10-ft range at intervals of 15 sec.

The El Salvador government is studying means of preventing the adverse ship motions at Acajutla. One possibility is to extend the breakwater so the swell strikes the coast at a point where the local orientation would reflect the waves away from the harbor. A second solution would be to construct a small breakwater at the base of the cliffs at the proper orientation to divert the swell northward.

Although at Acajutla the period of the ship response

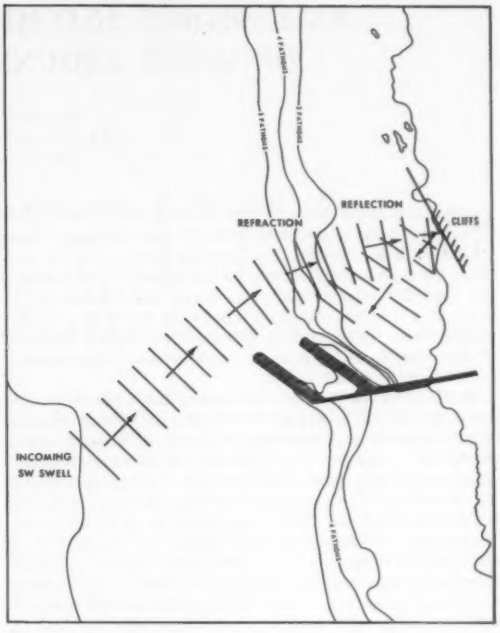

Figure 3. --Wave actions producing ship motions at Acajutla.

is similar to that of the swell (12 to 20 sec), it is possible for the two periodic motions to be quite different. At San Nicolas Harbor, Peru, for instance, Keith and Murphy (1970) found that incoming swell of 16 sec generated adverse ship motions transverse to the pier with periods of 50 to 150 sec. The reason was that the swell approached the moored ship at an angle so that the ship oscillated in a yawing motion with the mooring lines and the fender system acting as springs in a vibrating system. Ship response was complicated and variable.

Diffraction is another means by which waves can enter a protected harbor. As waves pass the end of a breakwater, a small percentage of the wave energy leaks behind the protecting wall, much as light penetrates around corners to a small degree. The amount of energy is small, however, and is generally such that waves have little effect on ship operations.

REFERENCES

Keith, J. M., and E. J. Murphy, "Harbor Study for San Nicolas Bay, Peru," Journal of Waterways and Harbors Division ASCE, Vol. 96, No. WW2, May 1970, pp. 251-273.

FALL STORM AND HIGH LAKE LEVELS SPELL DISASTER AROUND THE GREAT LAKES

Norton D. Strommen
NOAA Climatologist for Michigan
East Lansing, Mich.

Storms moving toward the Great Lakes Basin have always been a concern to ships operating on these inland waters. Today, interest in these storms has taken on a new significance to the farmer, the urbanite, and the sportsman. On November 13-14, 1972, the added impact these storms may exert was illustrated when rising waters forced over 15,000 persons to flee from their homes and caused unharvested fields to be flooded.

Fall is a period of maximum turbulence in the Great Lakes area, and storms occurring in that season take a heavy toll on shipping. Because of these storms, Professor Increase A. Lapham, an observer for the Smithsonian at Milwaukee, Wis., over 100 yr ago, urged the formation of a warning system to protect Great Lakes shippers. In 1869, Congressman H. E. Paine of Wisconsin introduced legislation to establish a weather warning system after his friend Lapham convinced him that it would save lives and reduce losses to property. This action led to the formal establishment of the National Weather Service in February 1870. Since that time, many notable storms have passed over the Great Lakes. Some of the early records are sketchy, but, since the late 1890's, two fall storms stand out. These storms occurred on November 9-10, 1913, and November 11-12, 1940, when storm-caused losses were in the millions of dollars. The 1940 Armistice Day storm is still considered by many to be the worst on record, when 70 lives were lost on Lake Michigan.

Records on lake levels date back to 1860 and provide a historic file that enables us to understand some of the many fluctuations of the Great Lake levels. The annual variation in lake levels averaged 1.55 ft for the two 20-yr periods, 1860 to 1879, and 1950 to 1969. Similarly, the annual range varied from a maximum of 2.2 ft to a low of 0.9 ft. The highest annual lake level is normally observed in the early summer month of June and the lowest levels during the winter months. Snowmelt and increasing rainfall during the spring months correspond with the rising lake levels. Increased sunshine and evaporation during the summer and fall contribute to the falling lake levels. These generally observed trends may be altered for short periods by passing storm centers. With westerly winds, the lake water may pile up along the east shoreline, while easterly winds tend to produce higher lake levels along the west shore. This is often referred to as lakewater ride-up or storm tides.

Sufficiently strong winds may result in a ride-up which causes levels 7 to 8 ft higher than normal, causing flooding of low-lying lands along the lake shore. At the same time, the opposite end of the lake usually experiences below-normal water levels and this often results in the grounding of the larger Great Lakes freighters. The groundings are most frequent in the shallow west end of Lake Erie.

Early on November 9, 1972, a weakening cold front pushed eastward toward the coastal mountains of northern California Three days later, this system appeared as a weak unorganized storm system over the Rocky Mountains of Colorado. As it moved out over the southern Great Plains, by 2100 on November 12, this system began to consolidate into a well-defined LOW over the Texas Panhandle. Meteorologists were busy examining their maps to determine just where this storm would go. If it followed the path of the past three storm centers into the northern Great Lakes, it would cause only minor problems for the southern Great Lakes. There was one major difference between this system and the last three. To the north, over the Canadian prairies, a high-pressure center was building and had become stationary. This center posed as a block to the northward movement of

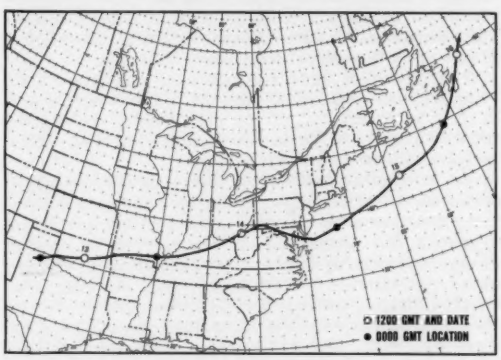

Figure 4.--Track of severe Great Lakes storm of November 14-15, 1972.

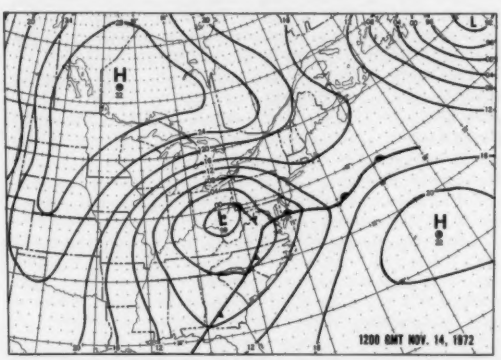

Figure 5.--Weather map of November 14, 1972 (1200 GMT), showing the tight pressure gradient over Lake Erie. The resulting winds caused severe damage on the southwestern shore of the Lake.

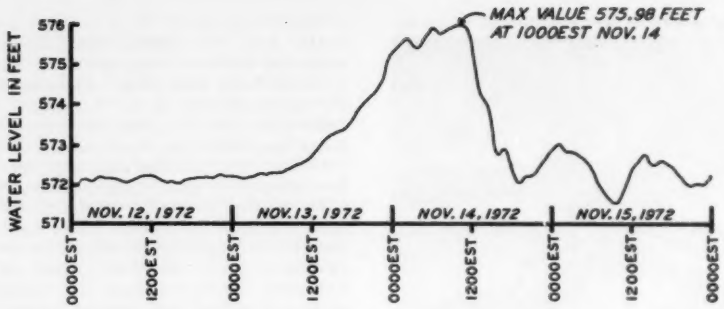

Figure 6. --Graph of the water level gage at Toledo, Ohio, shows rapid rise late on November 13, to a peak value at 1000 EST on the 14th.

the Texas storm center and served as an indicator of trouble ahead for the southern Great Lakes. By 1200 (7 a.m. EST) on November 13, the storm center was over northern Oklahoma. At 0000 on November 14, it had moved into southern Illinois. By now winds had swung to the northeast over the southern Great Lakes and surface lake water began to move slowly toward the southwestern shore. The rise was slow, almost unnoticeable at first, then more rapid as the wind slowly increased.

To the north, the Canadian HIGH held firm, just east of Lake Winnepeg, with little change in intensity. As the storm center continued eastward (fig. 4), the pressure gradients increased rapidly. With its path now well determined, the National Weather Service Forecast Offices at Cleveland and Detroit prepared to release advisories for storm tides. At 0025, Cleveland made an initial advisory release about the potential for high water along the southwestern Lake Erie shoreline. Two hours later, a supplemental updated release came from Toledo and advised of possible high water and flash flooding in that area. Two additional advisory updates were released from Cleveland at 0250 and 0435.

By 1200 on November 14 (fig. 5), the storm center was over southeastern Ohio and the Canadian high

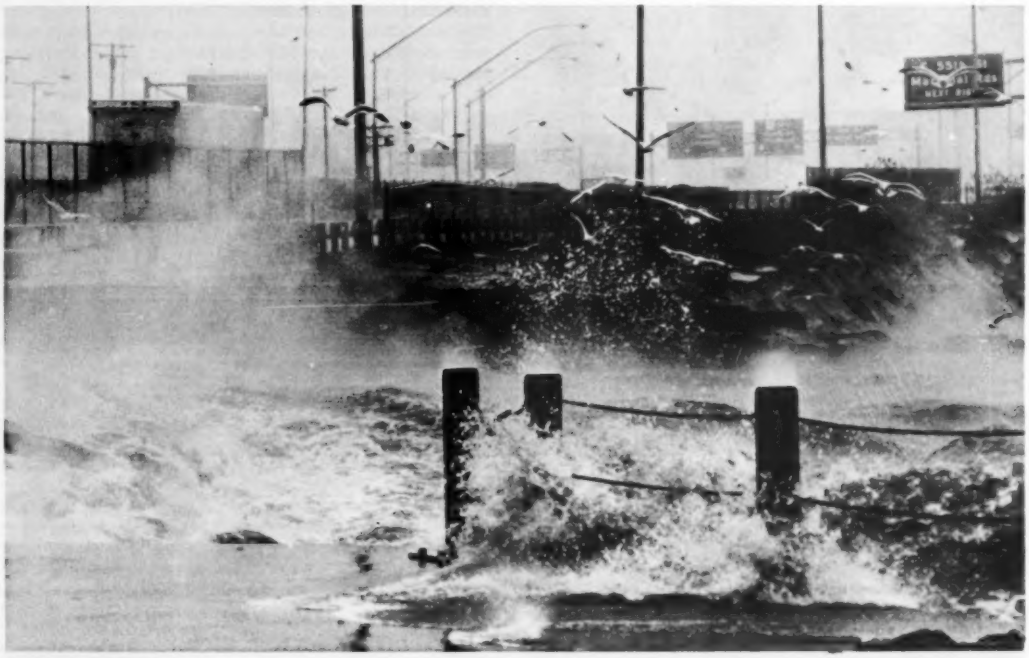

Figure 7. --Not even for the birds-- rain, wind and high seas on Lake Erie, November 14, drove even the gulls inland. Waves as high as 10 ft at Port Clinton, Ohio, pounded the breakwall along I-90 near downtown Cleveland. Wide World Photos.

Figure 8.--Road washed away by waves--A waterfront road along Sandusky's Cedar Point peninsula section suffered considerable damage in the November 14 storm. Wide World Photos.

center was still holding stationary with a ridge now extending southward into the Great Plains. Five ships reported from Lake Erie. The maximum winds were now northeasterly at 62 kt, about 30 mi north of Ashtebula, Ohio. During the next 6 hr, lake levels along the south and west shores of Lakes Erie, St. Clair, Huron, and Saginaw Bay reached record or near record heights. Water extended inland over a mile on the low-lying, flat, formerly glacial, lake bottom land. By 1600, November 14, the storm center was crossing the Appalachian Mountains and reforming over the East Coast and New Jersey. Pressure gradients began to weaken rapidly, and winds diminished and became more northerly. The water slowly began to recede but not before widespread damage to homes and unharvested crops had been accomplished.

A graph of the water level as recorded by the Lake Survey gage at Toledo is shown in figure 6. The highest level recorded there was 575.98 ft above the International Great Lakes Datum at 1500, November 14, or 88.6 in. above the 1955 low water datum for Lake Erie. On Saginaw Bay, the limits of the water level gage at Essexville were exceeded but the Coast Guard reported the highest water at the mouth of the Saginaw River as 68 in. above datum. These record levels topped by the pounding of 8- to 12-ft waves (fig. 7) had forced the evacuation of over 15,000 persons.

When the waters receded, over 1,000 homes had been severely damaged (cover) and hundreds of others suffered lesser damage. Total losses were estimated at $7.2 million in Michigan and $22 million in Ohio. The damage to crops was greater than would normally be expected, because of the late harvest season. Other damage included: washed-out roads,

Figure 9.--Erosion from waves and high water are well-illustrated at Silver Road Canal, St. Clair Shores, Detroit, Mich.

(fig. 8), breakwater and retainer walls, and extensive shore erosion (fig. 9) in most areas.

The extent of the damage can be attributed to a series of weather events. Greater than normal rainfall from July through the fall months, increased run-off, and reduced evaporation caused a reduction in the natural seasonal lowering of the lakes. Record high levels continued through September and October. With the storm moving to the more southerly fall and winter track, the northeast winds and higher lake levels combined to produce the extensive flooding. Water observation levels for Lake Erie over the past 100 yr indicated that new record heights were established during this November storm when the water level exceeded the November 1861 level by 0.3 ft. Lake levels for Lake Erie were about 0.7 ft higher during June and July 1952, but at that time of the year, vigorous storm centers are rare, thus reducing the likelihood of extensive flooding. While the losses to property could not be avoided, the timely warnings and evacuation of families to higher ground resulted in no loss of life and vindicated the arguments of Congressman Paine, that led to the establishment of the National Weather Service over 100 yr ago.

EASTERN NORTH PACIFIC TROPICAL CYCLONES, 1972

Eastern and Central Pacific Hurricane Centers
San Francisco, Calif., and Honolulu, Hawaii

The 1972 tropical cyclone season began in the eastern North Pacific Ocean on May 31 and continued through November 15. Twelve named tropical cyclones developed (table 1), of which four reached tropical storm intensity (≥34 kt) and eight reached hurricane strength (≥64 kt). A comparison with recent years' storm frequency is shown in tables 2 and 3. A total of eight hurricanes is near normal, but a total of four tropical storms is less than usual. This may be partly due to improved satellite investigation of the storm intensity and strong support from the 55th Weather Reconnaissance Wing, McClellan Air Force Base, Sacramento, Calif. Undoubtedly, a number of similar appearing depressions would have been upgraded to tropical storm intensity in earlier years when a closer surveillance of the storm was not possible.

Satellite coverage of the storm area was superior to that of previous years. The ESSA-8 gave a morning picture of the storm area, and ESSA-9, an afternoon picture. The latter was not received locally until the facsimile transmission in the late afternoon. Real-time ATS-1 and ATS-3 pictures became available routinely through the National Environmental Satellite Service (NESS) on August 2. ATS-1 became inoperative on October 17, 1972, after most of the season's activity was over. There was only a slight delay for photographic processing between picture exposure and viewing. Two exposures were made at, roughly, 20-min intervals about 1500 from ATS-3, and two from ATS-1 about 2200. Due to various limitations, only one satellite can be interrogated at a time. Because of greater emphasis being placed on Atlantic storms than on Pacific storms, and the limited satellite image processing capability of the Eastern Pacific Hurricane Center, fewer than the desirable number of pictures from ATS-1 were received. The ATS-1 pictures covered the western part (fig. 10) and ATS-3 the eastern part of the area (fig. 11), in excellent detail. The most spectacular ATS-1 picture was taken August 18 (fig. 10) with three storms, Celeste, Diana, and Estelle visible, and Fernanda shown organizing on the horizon.

Table 1.--Monthly distribution of tropical storms and hurricanes, 1972

	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
Tropical storms*	0	0	1	0	1	1	1	4
Hurricanes*	1	0	0	6	1	0	0	8
Total	1	0	1	6	2	1	1	12

*Tropical cyclones are counted for the month in which they formed.

Table 2.--Frequency of tropical storms and hurricanes combined by months and years

	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
1966	0	1	0	4	6	2	0	13
1967	0	3	4	4	3	3	0	17
1968	0	1	4	6	5	3	0	19
1969	0	0	3	2	4	1	0	10
1970	1	3	6	4	1	2	1	18
1971	1	1	7	4	2	2	1	18
1972	1	0	1	6	2	1	1	12
Totals	3	9	25	32	21	14	3	107
Average	0.4	1.3	3.6	4.6	3.0	2.0	0.4	15.3

Note: Tropical storms have not developed before May nor after November since full operational satellite coverage began in 1966. Only those storms which had their origins east of 140°W are included in this table.

Table 3.--Frequency of tropical storms reaching hurricane intensity by months and years

	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
1966	0	1	0	4	2	0	0	7
1967	0	1	0	2	1	2	0	6
1968	0	0	0	3	2	1	0	6
1969	0	0	1	1	1	1	0	4
1970	1	0	1	1	0	1	0	4
1971	1	1	5	2	2	1	0	12
1972	1	0	0	6	1	0	0	8
Total	3	3	7	19	9	6	0	47
Average	0.4	0.4	1.0	2.7	1.3	0.9	0	6.7

Forty-six reconnaissance flights were flown by the 55th Weather Reconnaissance Wing with an average of 15 observations per flight. The flights usually reported the center position, after traversing the eye in several directions, when aircraft capability permitted. Flights remaining overnight at Acapulco or

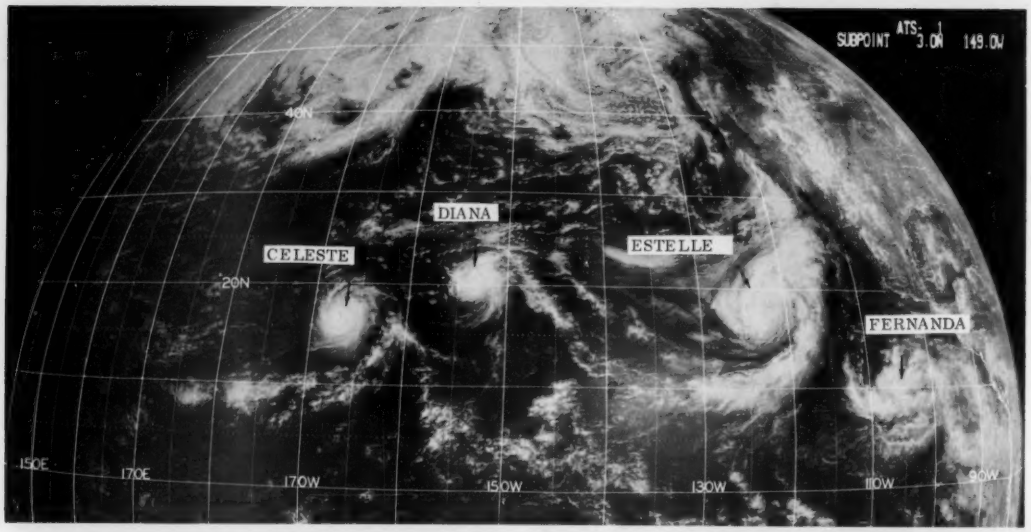

Figure 10.--A rare photograph--Four tropical cyclones occurring at the same time in one ATS-1 satellite picture. From left to right: hurricane Celeste, hurricane Diana, tropical storm Estelle, and a tropical depression which was named Fernanda on August 19, as they paraded across the eastern North Pacific on the 18th.

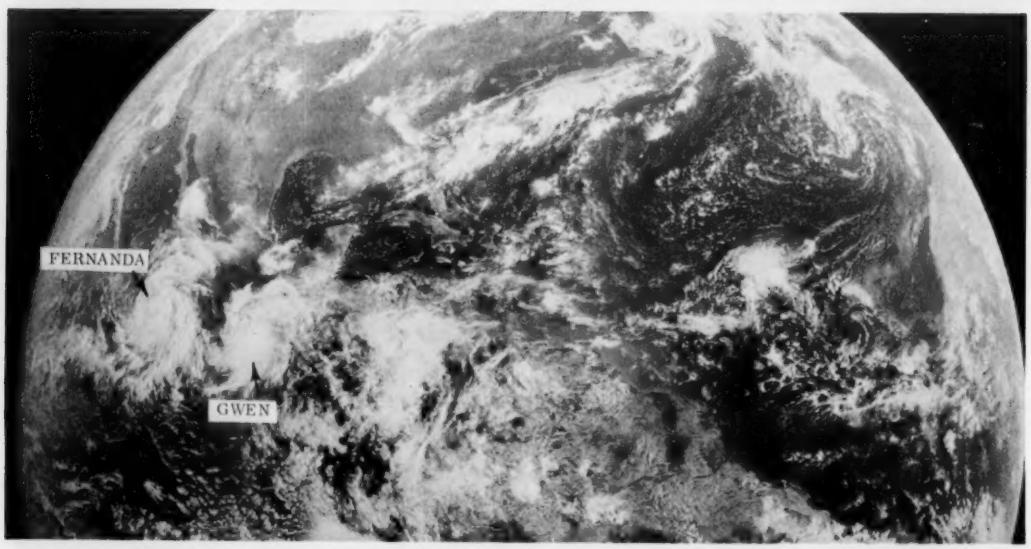

Figure 11.--ATS-3 presents a better coverage of the eastern portion of the area as it picks up Fernanda and Gwen on August 21.

Honolulu allowed extended range observations of Celeste, Diana, and Fernanda. This is the second year that California-based aircraft have used Acapulco to fly reconnaissance on a storm one day, and then fly back to the home base via the storm the next day. Direction and speed of movement were observed and reported on Fernanda, Gwen, and Hyacinth due to the greater time available to remain in the storm area. This became increasingly important as Gwen and Hyacinth moved into northern waters and threatened southern California.

Few surface observations were received from ships near the storms. One vessel, a 117-ft square-rigged sailing vessel, the REGINA MARIS, with 53 persons

on board was damaged and needed assistance as a result of Celeste. USAF reconnaissance aircraft found the vessel some distance from its estimated position and guided a rescue aircraft with gasoline, pumps, and supplies to the distressed ship. The reconnaissance aircraft then continued on its mission to monitor Celeste.

Fifty to sixty fishing craft, in a 300-mi-long lane along 10°N from 127°W westward, were threatened by Joanne before she altered her course northwesterly and northerly on October 3. The vessels were north of a very active Intertropical Convergence Zone and west of the hurricane, which was moving a little faster than the vessels' capability to outrun the storm. They elected to enter the Intertropical Convergence Zone rather than risk the storm. As the storm moved northwestward, the Zone weakened, ending the threat.

A number of vessels altered their courses to elude storms. One in particular during August zig-zagged through the field on a trip from Honolulu to the Canal Zone. Forty-five degree course changes were made where sea room allowed. Near the Mexican coast, where shipping is the heaviest, less freedom of movement is available and speed changes were used in an attempt to evade the storms.

The highest synoptic wind speed reported by surface vessels during the season was 60 kt, by the POLARIS SEAL off Cedros Island and the J. V. CLYNE during Joanne. A fishing vessel report during the early stages of Celeste, gave an estimate of 80- to 90-kt winds. The strongest wind estimate from reconnaissance aircraft was reported by the aircraft that flew into Gwen on August 26--125 kt.

Considerable concern for Southern California beach areas was generated by hurricane Gwen. High seas and surf and a storm tide were forecast. The seas and surf verified, the storm tide did not. Hurricane Hyacinth moved into Southern California September 6, but had all but dissipated prior to reaching the coast. Hurricane Joanne moved across Lower California near Laguna Chapala and then to the mainland near Puerto Pensaco and caused considerable local flooding in northern Baja California, Sonora, and Arizona.

Some of the more important ship reports are mentioned in the summaries of individual tropical cyclones which follow. Cyclone tracks are shown in figures 12 and 13, and cyclone highlights are summarized in table 4. All times are GMT unless otherwise stated.

HURRICANE ANNETTE, MAY 31 TO JUNE 7

A tropical disturbance appeared for several days on the Intertropical Convergence Zone prior to the 31st. The veteran tropical storm reporter, INGER, passed to the northeast of an area of squally weather and veering winds during the early morning hours of the 31st. The disturbance reached storm intensity, and was named Annette on the 31st when the WORLD NAUTILUS reported 35-kt winds in a worded message, and also indicated 2- to 3-mi visibility in rain and 12- to 15-ft seas.

Ship routing apparently cleared ships from the storm area and few surface reports were received, although the BUCKEYE STATE, LAPLAND, TACOMA MARU, VITIM, and the DNTE helped locate the storm with peripheral reports near 13°N, 107°W from May 31 through June 3.

Air Force reconnaissance and satellite pictures indicated the storm drifted and developed hurricane intensity on the 4th; it weakened and accelerated north and northeastward on the 5th. Winds near her center were 75 kt, gusting to 85 kt, and gales extended out

Table 4.--Summary of Eastern North Pacific tropical cyclones, 1972

Name and intensity	Lifespan	Origin (°N, °W)	Dissipation (°N, °W)	Highest reported wind speed (kt)	Estimated maximum wind speed (kt)	Lowest reported pressure (mb)	Coasts affected	Remarks
Hurricane Annette	May 31-June 7	13, 107	16, 103	40 Ship unknown	67 Satellite	993 USAF recon	Mexico, southeast of Manzanillo	No damage or property loss reported
Tropical storm Bonny	July 27-30	19, 109	22, 118	30	45 USAF recon	993 USAF recon	None	None
Hurricane Celeste	August 6-22	15, 120	22, 173	55 WJZB	100 USAF recon	996 USAF recon	Johnston Island	REGINA MARIS damaged, required aid; two injured.
Hurricane Diana	August 10-20	9, 114	21, 157	60 USCGC MELLON	100 Satellite	968 USAF recon	Hawaii, Maui	Hampered the rescue of REGINA MARIS.
Hurricane Estelle	August 15-23	9, 111	27, 136	35 COLUMBIA	75 Satellite	1004 SAN JUAN EXPORTER	None	None
Hurricane Fernanda	August 19-31	11, 104	26, 136	52 EASTERN GLORY	100 USAF recon	953 HOSELSTEIN	None	None
Hurricane Gwen	August 21-31	9, 96	29, 121	40 SCOTSTOWN	125 USAF recon	941 USAF recon	None	Passed over Socorro Island night of the 26th.
Hurricane Hyacinth	August 28-September 6	11, 94	23, 110	45 SHEAF TYNE	110 USAF recon	962 USAF recon	Clarion Island, 75 mi north of center at 0181	None
Tropical storm Iva	September 13-22	12, 102	17, 128	40 FRANCE MARU	45 USAF recon	999 USAF recon	None	None
Hurricane Joanne	September 29-October 6	12, 105	31, 113	60 POLARIS SEAL J. V. CLYNE	80 USAF recon	971 USAF recon	Crossed Baja California early on 6th. Moved over Point Penasco with maximum winds of 45 kt. Locally heavy rain occurred the night of the 5th to 6th.	None
Tropical storm Kathleen	October 17-19	15, 109	21, 108	None	40 Satellite		Mexican coast, south of Mazatlan	None
Tropical storm Liza	November 13-15	11, 97	11, 105	35 WORLD UNION	50 Satellite	1007 BENSTAC	None	None

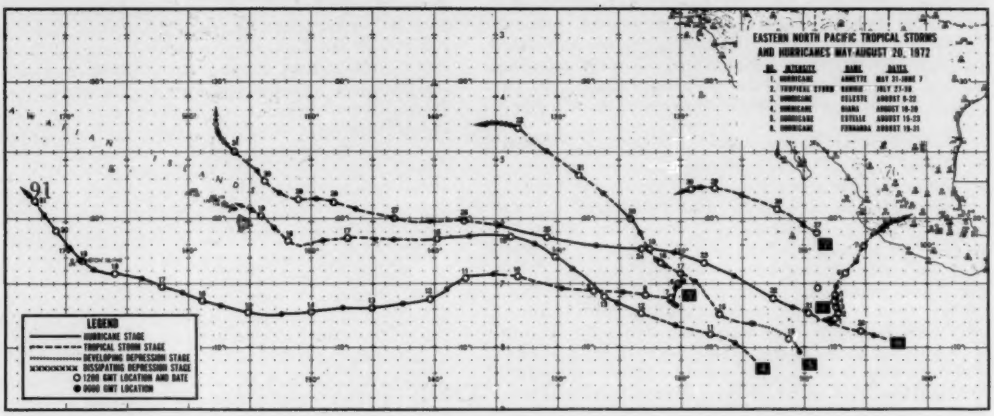

Figure 12. --Tracks of eastern North Pacific tropical storms and hurricanes, May-August 20, 1972.

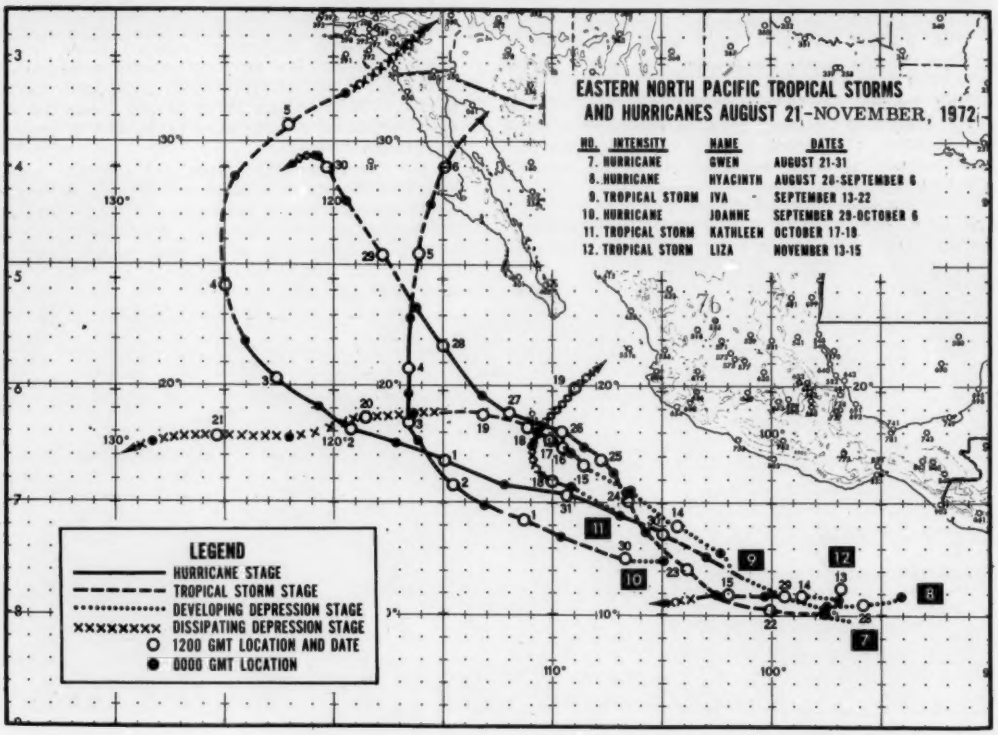

Figure 13. --Tracks of eastern North Pacific tropical storms and hurricanes, August 21-November, 1972.

more than 100 mi in all directions on the 4th. On the 6th, it reached a point 300 mi southwest of Manzanillo. Forty-knot southerly winds and 15-ft swells laced the BUCKEYE STATE at 1800 on the 6th some 250 mi south of Manzanillo. Annette reached the coast about 60 mi southeast of Manzanillo at about 1800 on the 7th.

No damage to shipping or cargo has been reported because of the storm, and no accounts of property damage has been received in the Manzanillo area despite several days of rainy weather.

TROPICAL STORM BONNY, JULY 27 TO 30

Unlike Annette, the eastern North Pacific's first tropical storm of the past season, Bonny did not become a hurricane. July-born Bonny popped up suddenly near 19.0°N, 109.5°W, late on the 27th. The storm adopted a west-northwesterly course, passing north of the Islas de Revillagigedo. Bonny achieved her greatest intensity (45-kt winds near her center with gusts to 70 kt) near 21°N, 114°W, about 24 hr after she was first detected. She turned westward and decelerated during the 29th, and her top winds dropped to 35 kt with gusts to 45 kt. Bonny was downgraded to a depression at the close of the 29th; she dissipated near 22°N, 120°W, early on the 31st.

HURRICANE CELESTE, AUGUST 6 TO 22

A tropical disturbance near 450 mi south of La Paz, Mexico, on the 2d moved westward and stalled near 15°N, 120°W, on the 4th. It developed slowly into a tropical storm by the 6th, near 15°N, 120°W; it then moved slowly westward. No ships reported in the area until 0000 on the 7th when a vessel (WGBC) about 90 mi south of the center indicated westerly winds of 20 kt and a pressure of 1006.4 mb. Ships remained clear of Celeste except for the SANTA ISABEL MARU, which passed 150 mi southwest of the center at 1800 on the 8th.

A radio telephone call from the STAR TRACK estimated 80- to 90-kt winds near 16°N, 123°W, at 0054 on the 9th. During the rapid development, a three-masted square-rigged vessel, the REGINA MARIS, became involved in the storm and was damaged by high winds and rough seas. It began taking on 2,000 gal. of water an hour and issued a distress call. Two injured persons were treated onboard. The Air Force reconnaissance aircraft on a mission to observe the hurricane was alerted to the distressed vessel. That aircraft found it some distance from its estimated position, and guided a rescue aircraft to the REGINA MARIS. The rescue aircraft dropped pumps, gasoline, and supplies to the damaged vessel. The reconnaissance aircraft then continued on its mission. The VISHEA TRITH reached the sailing vessel and took it in tow until the USCGC MELLON took over late on the 13th. Rescue and towing operations were complicated by the aftereffects of Celeste and the effect of hurricane Diana, which followed 1,000 mi and 4 days after Celeste.

Hurricane Celeste crossed 140°W at 14°N about 0900 on the 12th. For the next 2 days, she moved west-southwestward at about 10 kt. The storm passed south of the Hawaiian Islands on the 15th. The closest point of approach was near 0600 on the 16th, at a point 320 mi south-southwest of South Point on the Island of Hawaii. At this time, Celeste had turned gradually to a west-northwesterly course and headed for Johnston Island, a small coral island 700 mi southwest of Honolulu. Early (72-hr) forecasts provided ample opportunity for precautionary measures to be taken at Johnston. Later, the forecast for close passage of Celeste to Johnston caused the Air Force to evacuate all personnel from the island; this was accomplished the day before she struck. Celeste passed approximately 20 mi northeast of Johnston Island at about 0100 on the 20th. Damage reports from Johnston Island indicated only relatively light damage because the storm center passed north of the island and extensive reefs protect Johnston on the north side. Intensive preparation for the storm undoubtedly reduced damage potential. The hurricane undertook a northward turn just prior to passing Johnston and began to weaken. Nevertheless, at 0600 on the 21st, the AMERICAN LANCER, only approximately 20 mi to the north, was pounded by 55-kt gales, heavy rain which reduced the visibility to 0.5 mi, and seas of 10 ft, together with 24-ft swells. She was downgraded to a tropical storm by 1200 on the 22d near 21°N, 172°W, and rapidly dissipated thereafter.

Celeste was of considerable meteorological interest. The central Pacific sees relatively few tropical storms each year. Much rarer is a hurricane that forms off Mexico and moves west across the central Pacific while maintaining hurricane intensity. Also interesting was the fact that Celeste moved with few sudden changes of direction, intensity, or shape. The storm-generated swell was felt on the south shores of the Hawaiian Islands. Swell estimated at 6 to 9 ft high in deep water caused occasional surf to 15 ft on exposed shores. The southerly swells from Celeste were observed in the Hawaiian Islands during the period of August 15th-17th.

HURRICANE DIANA, AUGUST 10 TO 20

Diana developed in the wake of Celeste on the 8th. A circulation was first indicated in satellite pictures on the 10th near 9°N, 144°W, at 1800. Squalls and showers extended out 300 mi from the center. Winds of 20 kt or less were reported 200 to 500 mi from the center by the SANTA ISABEL MARU, CONON FOREST, and the STEEL ADVOCATE. The CONON FOREST, north of and converging with the storm, altered her course on the night of the 10th. She then sailed parallel to and at nearly the same speed as the storm, which increased to hurricane intensity on the night of the 12th near 13°N, 124°W, remaining in the vicinity of the storm until the 18th. The VISHEA TRITH, towing the disabled 117-ft square-rigged sailing vessel, the REGINA MARIS, with 53 passengers, was headed northeast ahead of the storm in 30- to 40-kt winds to rendezvous with the USCGC MELLON near 17°N, 126°W, on the night of the 12th; the hurricane center (fig. 14) was about 120 mi to the south. The tow was transferred in strong winds and

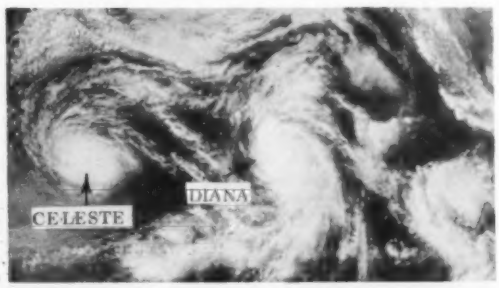

Figure 14.--ATS-1 picks up Celeste and Diana on August 12. The VISHEA TRITH, towing the disabled REGINA MARIS, transferred her tow to the USCGC MELLON about 120 mi north of Diana.

high seas, and the MELLON, bucking winds of 35 to 50 kt, headed northeast and east away from the storm.

A reconnaissance on the 14th showed no change in either central pressure or maximum wind. On the 15th, the Air Force reconnaissance reported Diana had weakened somewhat. The central surface pressure had risen to 982 mb, and maximum surface winds had diminished to 55 kt. Shortly after this reconnaissance report was received, Diana was downgraded to a tropical storm. At this point, Diana also changed course to the west and increased speed to 16 kt. The next three reconnaissance observations on the 17th and 18th gave no reports on minimum surface pressure, but all reported maximum surface winds of 45 to 55 kt with no changes in storm characteristics. Until 1800, Diana moved on a steady westerly course at an average speed of 16 kt. At this time the center was 300 mi east of the Island of Hawaii and the storm center was forecast to pass very near the southernmost point of the Island on the 18th. Early on the 18th, Air Force reconnaissance located the center north of the predicted path and a sharp change in both course and speed of Diana was in progress. A tropical storm warning advisory was then issued stating the storm would pass to the north. Reconnaissance on the 19th indicated further slowing and curvature toward the north. The central pressure of the storm was measured at 987 mb with maximum surface winds of 50 kt indicating further weakening had occurred.

On the morning of the 20th, the Air Force reconnaissance plane located the center of Diana 30 mi north of the Island of Maui with a minimum surface pressure of 1005-mb and maximum surface winds of 25 kt. Diana's career was over. She did manage to cause some damage, however. On the morning of the 18th, surf estimated at greater than 25 ft began pounding the southeast coast of Hawaii. At Kapoho Beach, damage to four homes was estimated at $70,000, excluding furnishings. Although rains did not produce floods, rainfall was large over most of the eastern side of Hawaii with pockets of very large rainfall occurring. Ten in. fell in a small area northeast of Hilo, and 8 in. fell in the Punaluu area southwest of Hilo. From rainfall data of the other islands, it appears only Maui received rainfall in any large amounts that were directly a result of proximity to Diana. One area along the northeast coast received up to 6 in. of rain during Diana's pass by the island.

HURRICANE ESTELLE, AUGUST 15 TO 23

After Celeste and Diana broke away and moved into higher latitudes, squalls and thunderstorms continued along the Intertropical Convergence Zone and Estelle was born. On the 13th, satellite pictures showed signs of another circulation developing in the vicinity of Clipperton Island, 10°N, 115°W. By early morning on the 15th, a depression was located 650 mi southwest of Manzanillo moving westward at 8 to 10 kt. No ships were in the vicinity of the LOW, but several were within 300 to 500 mi of the center. These included the SETUN MARU, NORBEGA, COLUMBIA, and the GRIESHEIM. Satellite pictures taken on the 15th indicated continued organization and intensification of the depression, and late afternoon pictures suggested the system had become a tropical storm moving northwestward at 12 kt with maximum winds of 40 kt near the center. The deepening of the storm was accompanied by a slower northwestward movement. The only reported gale wind of the storm was by the LLKJ, about 150 mi from the center at 1800 on the 17th. The SAN JUAN EXPORTER, on a northwesterly course, was closing on the storm late on the 18th. With winds and seas increasing, she elected to alter her course and pass to the south of the storm. Had she continued her speed and course, she would have passed through the center on the morning of the 19th, with 60-kt winds gusting to 80 kt.

Gradual intensification to hurricane strength continued. By late on the 19th, winds were estimated at 75 kt. The hurricane continued moving northwestward at 8 to 10 kt, began weakening, and was downgraded to a tropical storm late on the 20th about 1,300 mi west of Puerto Vallarta. Estelle continued on a northwesterly course at 10 to 12 kt until the morning of the 22d, when the circulation weakened with maximum winds of 30 kt. She then entered more westerly flow around the equatorial side of the Pacific high pressure area and dissipated near 27°N, 137°W, on the 23d.

HURRICANE FERNANDA, AUGUST 19 TO 31

An area of cloudiness about 500 mi south of Manzanillo, Mexico, on the 18th, developed rapidly into tropical storm Fernanda on the 19th. The FERNFIELD, 200 mi east of the center reported a southerly 25-kt wind, but the long swells reported were also from the south, indicating a recent development of the LOW. As the FERNFIELD sailed northwestward, she encountered heavy rains as the wind backed to southeast. The GREEN WAVE and ILYA ULYANOV were ahead of and outrunning the storm, but the FILEFJELL, heading southeastward, altered her course to the north with winds increasing to 40 kt, 180 mi northeast of the center, by 1800 on the 21st, near 12°N, 110°W. After sailing south of Diana on the night of the 16th, the WONOSARI continued on an easterly course to the Panama Canal. She crossed 250 mi south of Estelle during the night of the 19th and headed for an intercept with Fernanda in a little over 2 days. She altered course to the southeast late on the 21st, as Fernanda continued to intensify. The WONOSARI passed within 150 mi of Fernanda as the storm intensified to a hurricane, but reported only 20-kt winds at 0000 on the 22d. Passing beyond Fernanda, she went through the southern part of tropical storm Gwen during the night of the 22d and then into thunderstorms and squalls that were organizing to form a depression south of Guatemala on the night of the 24th.

Meanwhile, Fernanda continued as a hurricane on a west-northwesterly course developing 90-kt winds late on the 23d (fig. 15) and 100-kt winds that night. The HOSELSTEIN, 200 mi southwest of the center, reported 45-kt winds and the BOGOTA, STEEL APPRENTICE, MOHAWK, THOR I, BANASOL, HONGKONG BEAR, and BRADFORD ISLAND were all in the vicinity of the hurricane, between the 23d and 24th. The strongest wind reported was 52 kt by the EASTERN GLORY on the 24th, 125 mi west-northwest of the hurricane, then centered near 18°N, 127°W. Fernanda was downgraded to a tropical storm on the morning of the 26th and crossed 140°W near 20°N during the afternoon of the 27th. She then moved westward and a little north, passing 150 mi north of the main Hawaiian Islands, Hawaii on the 30th and Kawai on the 1st. She continued to weaken and was

Figure 15. --The cloud patterns of the North Pacific, with hurricane Fernanda swirling off of Baja California, are captured by the ATS-1 satellite on August 23, 1972.

last seen on the weather maps near 31°N, 157°W, on September 3.

HURRICANE GWEN, AUGUST 21 TO 31

A tropical disturbance near 9°N, 90°W, on the 20th, moved westward to 400 mi east-southeast of Acapulco and developed into tropical storm Gwen during the night of the 21st. Forty-knot winds were reported by the CONTINENTAL MERCHANT and the SCOTSTOUN. The RICE QUEEN, about 75 mi offshore near Point San Telmo, reported 35-kt winds as the storm passed south of them. On the 22d, the course of the storm changed to northwesterly and the speed increased to about 15 kt. The strongest winds increased slowly to hurricane intensity on the 24th, and the center was located on satellite pictures near 16°N, 107°W, 400 mi southwest of Zihuatanejo. The hurricane continued northwestward, followed by Air Force reconnaissance aircraft, and in satellite pictures, reaching its greatest intensity 100 mi southeast of Socorro Island with estimated winds of 125 kt near the center. The hurricane passed over Socorro Island during the night of the 26th, a small but intense storm. The BANASOL, after passing north of Fernanda, passed south of Gwen on the 27th. The URRW outran the storm to the north. Numerous ships reported from the periphery of the storm: the AMERICAN LANCER, BUM WOO, FRESNO CITY, GRISCHUNA, NORTH BREEZE, SHELDON LYKES, TEXAS, and unlisted ships, JBVY, JHOY, and JPSI. On the 29th, the hurricane decreased to tropical storm intensity near 25°N, 117°W. It continued northwestward, weakening further and becoming a tropical depression about 250 mi southwest of San Diego, where it dissipated late on the 30th. A weak surface LOW continued in the general area through September 1.

HURRICANE HYACINTH, AUGUST 28 TO SEPTEMBER 6

A circulation was indicated on satellite pictures 300 mi south of the Gulf of Tehuantepec on the 27th, and a tropical disturbance bulletin followed reports by the ACHILLE LAURO, CHEVRON ARNHEM, MOHAWK, and ALMIRANTE. The disturbance maintained its intensity and moved westward through 1800 on the 29th, when it developed into tropical storm Hyacinth and moved west-northwestward. The BANASOL reported 35-kt winds 150 mi to the northeast, and the THOMAS M reported 30-kt winds 100 mi north of the center at 0000, and 45-kt gales, at 0600 on the 30th, The EASTERN GLORY also measured 38-kt gales, slightly farther north. Air Force reconnaissance observed the storm at 1800 on the 30th, finding a central pressure of 984 mb and estimating winds of 80 kt near the center. The hurricane was moving west-northwestward at 12 kt. On the 31st, the Air Force found a central pressure of 972 mb and estimated winds of 110 kt. No flight was made on September 1, but on the 2d the lowest pressure of 962 mb was found near 19°N, 120°W. Such a central pressure could easily have developed winds in excess of 100 kt.

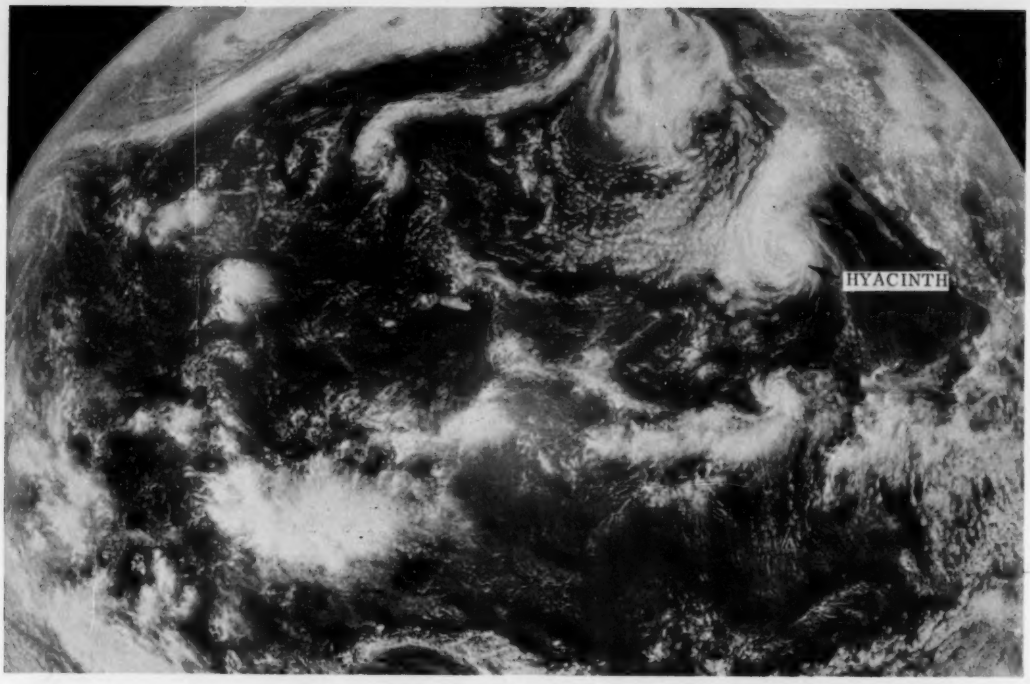

Figure 16. --Hurricane Hyacinth begins to weaken as it passes over cooler water on September 3, 1972.

The storm weakened on the 3d (fig. 16) and at 1800 the Air Force estimated winds of 70 kt. At 0000 on the 4th, it was downgraded to tropical storm intensity. The storm continued to weaken as it passed over cooler water and took a more northerly and northeasterly direction, reaching its westernmost point on the 4th near 27°N, 125°W. Thirty-knot winds were reported by the CHOKO MARU and two ships which were unlisted in the AMVER Bulletin--the GAUG and 4YQT. Thirty-knot winds were reported by GAUG, 60 mi northwest of the center, by the PECAN, 100 mi southwest of the center, and by the CHOKO-MARU and 4YQ'I', 60 mi west of the center, late on the 4th.

Further weakening continued as the storm reached the coast. It went inland between San Diego and Los Angeles with only 20-kt winds.

TROPICAL STORM IVA, SEPTEMBER 13 TO 22

Several areas of squalls and thunderstorms, which were active between 5°N and the Central American coast westward to 100°W on the 11th, slowly organized into a tropical disturbance about 300 mi south of Salina Cruz, Mexico. On the 12th, the disturbance moved to near 12°N, 94°W. A 250-mi diameter cloud area showed on satellite pictures on the 13th with the center located about 300 mi south of Acapulco. The ARISTOCRATIS reported 25-kt winds and occasional heavy rain 150 mi northeast of the depression. A northwestward movement of 12 kt was measured on the 14th, but on the 15th it slowed and intensified, becoming tropical storm Iva near 16°N, 108°W, at 1800. Iva continued moving northwestward but covered a distance of only 120 mi in 60 hr between 0000 on the 16th and 1200 on the 18th. During this period, maximum winds of 45 kt were estimated. After 0000 on the 19th, the storm curved westward; by 1800, it had weakened to depression stage moving westward in the trade winds. It was still visible in satellite pictures for several days, but reports from the FRANCE MARU, OWARI MARU, STATE OF PUNJAB, and GWDS indicated no abnormal winds or seas near the cloud mass after 1800 on the 22d.

HURRICANE JOANNE, SEPTEMBER 29 TO OCTOBER 6

Hurricane Joanne started as a tropical disturbance 250 mi south of the Guatemala coast on September 26. Satellite pictures and reports from the LEUVE LLOYD and the VIET THONG TIN I indicated squally weather. The disturbance moved westward at about 15 kt on the 27th and 28th to 11°N, 99°W, as it slowly developed a homogeneous cloud pattern. By the 29th, a closed circulation had developed near 12°N, 104°W, with 30-kt squally weather reported by the STEEL DESIGNER about 100 mi northeast of the center. Squalls extended to the coast in the northeast quadrant. Further development continued in the following 24 hr. The VIET THONG TIN I reported 40-kt winds about 60 mi from the center, which was located near 13°N, 106°W, early on the 30th.

Joanne moved west-northwestward at about 10 kt developing hurricane intensity on October 1 (fig. 17). Winds were estimated at 64 kt by Air Force reconnaissance near 15°N, 112°W. No ships were near the

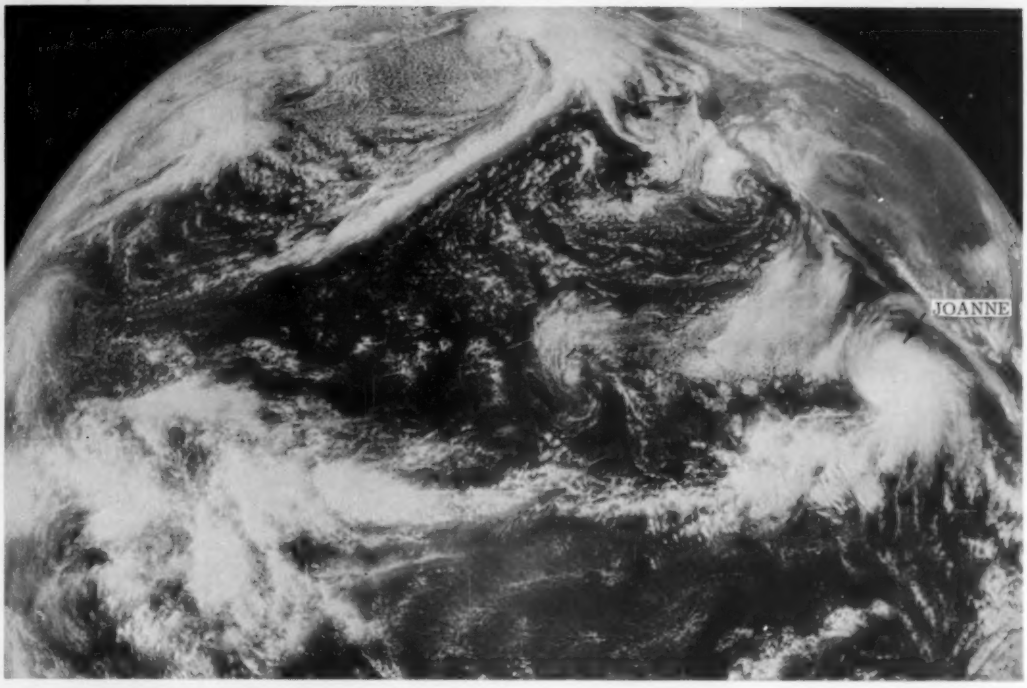

Figure 17.--A large portion of the eastern North Pacific is under Joanne's influence as she gains hurricane intensity on October 1, 1972.

center, but the SUGAR EXPORTER, VIET THONG TIN I, STEEL VOYAGER, KASUGASAN MARU, and AMERICAN CORSAIR reported from the periphery of the storm. None of the ships experienced winds of more than 25 kt. A more northerly direction began after the 1st, and many ships 200 to 500 mi from the center, excellent satellite pictures, and daily Air Force reconnaissance flights kept the storm well located. Fifty to sixty fishing vessels, near 10°N between 121° and 127°W, were caught in heavy weather under a band of clouds that fed moisture to the hurricane located to the east-northeast. A westward movement of the hurricane was anticipated at the time, and the fishing vessels moved off southward through the squalls to quieter waters. A more northerly course was taken by Joanne between the 2d and 3d, and recurving started with the center reaching 22°N, 117°W, on the 4th. The AMERICAN LARK, PENDRECHT, SANTA MARIA, TAMPA, and WIELDRECHT were among the vessels between 100 and 500 mi from the center. None reported more than 30-kt winds at a time when the maximum near the center was estimated at 80 kt.

The hurricane weakened to a tropical storm during the night of the 4th near 25°N, 116°W, with 50-kt and 60 kt winds reported by the VARICELLA 75 mi northeast of the center. Joanne crossed into Sebastian Vizcaino Bay late on the 5th with numerous ships reporting 30- to 55-kt winds. The J. V. CLYNE, running dead slow to allow the storm to pass to the north, encountered 60-kt winds and very rough seas near the center of the storm during the night of the 5th. The POLARIS SEAL, anchored off the west side of Cedros Island reported a pressure of 982 mb and winds of 60 kt early on the 6th. The storm crossed Baja California at that time. Winds at Point Penasco were 45 kt early on the 6th, and by that night a 1004-mb LOW was centered over Sonora, Mexico, and Pacific winds returned to normal.

TROPICAL STORM KATHLEEN, OCTOBER 17 TO 19

Tropical storm Kathleen developed in the convergence zone 300 mi southwest of Manzanillo, Mexico, on the 17th. She was one of a number of vortices that developed along the Intertropical Convergence Zone in October. Kathleen was identified and tracked primarily by satellite pictures from ESSA 8 and 9. The storm was followed as a disturbance near 10°N, 95°W, on the 15th, to 15.2°N, 109.5°W, at 0000 on the 18th when she reached tropical storm intensity. At that time, she was moving west-northwestward at 10 kt with an estimated maximum wind speed of 40 kt. By 1200 that day, satellite pictures indicated she had weakened and moved northward. She was then downgraded to a tropical depression. During the night, the direction of movement changed to the northeast, and, on the 19th, Kathleen approached the Mexican coast with showers and light winds.

TROPICAL STORM LIZA, NOVEMBER 13 TO 15

Rare November eastern Pacific tropical cyclones usually form close to the coast, recurve quickly, and

are often potent. Tropical storm Liza, the last storm of the year, developed in the right vicinity, near 11°N, 97°W, on the 13th, but neither recurved nor became potent. Early on the 14th, the BENSTAC reported a pressure of 1007 mb near the storm. She moved westerly and reached tropical storm strength on the 14th near 11°N, 99°W. Maximum winds were estimated at 50 kt with gusts to 70 kt. Air Force reconnaissance on the 15th indicated only an area of cloudiness with no cyclonic circulation at the surface. Liza was then classified as an easterly wave and dissipated before crossing the 105th meridian.

Hints to the Observer

OBSERVING PROCEDURES

Experienced observers may find some time-saving steps in the following procedure and new observers may find a way out of the seeming dilemma of preparing a weather report on NOAA Form 72-1 "Ship's Weather Observations (fig. 18).

Allow yourself 15 to 30 min to complete the observation. The pressure reading should be done within the last minute or two before the hour.

By following the routine steps listed below and to the right of the Dew Point Table, repetition can be avoided in taking and encoding the observation:

1. Indoors. Encode and enter columns 2-7, 13, 24-27, 32, and 40.

2. Before going outdoors, wet the wick of the psychrometer and get a pencil and note pad for jotting down outdoor elements.

3. Outdoors.
   a. Decide on visibility, present weather, total sky cover, and cloud types.
   b. Aspirate the psychrometer while determining wave height, direction, and period. (You may want to observe wind waves and swell before starting the observation, and simply check to see that they haven't changed at this time.)
   c. Read and record the dry-bulb (air temperature) and wet-bulb temperatures.
   d. Determine the height of the lowest cloud and eighths of the lowest cloud layer, if low or middle clouds are present.
   e. Determine the wind direction and speed from the sea (or apparent wind from ship rigging and smoke).

4. Come indoors with data noted in step 3. Encode and record data for:
   a. Wind direction and speed. (Convert apparent wind to true wind (cols. 9-10).)
   b. Sky condition (cols. 8 and 19-23).
   c. Visibility and present weather (check to see if they have changed (col. 11-12)).
   d. Air temperature, wet-bulb, and dew point (cols. 16-17, 18, 30, and 33).
   e. Wind waves and swell, using as many swell groups as necessary to describe the sea conditions (cols. 35-39).

5. Copy the observation code on the radiotelegram form (except for the pressure).

6. Read the pressure (convert to millibars, if necessary) and enter it in columns 14 and 15, and on the radiotelegram form.

7. Deliver the coded report to the radio officer.

8. Check the upper half of column 41 when the message is sent ashore and enter your initials in the lower half of column 41.

WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD WEATHER OBSERVATIONS. TO US, THESE EXCELLENT OBSERVATIONS ARE PRICELESS. WE CERTAINLY DO APPRECIATE RECEIVING THEM ON A REGULAR BASIS.

Form Approved; Budget Bureau No. 41-R1258

SHIP'S NAME ☐ S/S ☐ M/V	MONTH AND YEAR 19____	BAROMETER NUMBER	NOAA FORM 72-1 (10-71) U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NATIONAL WEATHER SERVICE
CALL SIGN	VOYAGE FROM:	DATE LAST CHECKED	SHIP'S WEATHER OBSERVATIONS
COUNTRY OF REGISTRY	VOYAGE TO:	CORRECTION	

GENERAL INSTRUCTIONS
(See observing handbook for more details)

1. Fill in all blanks on upper left-hand side of this form.
2. Check appropriate box in column 32.
3. Before entering, convert:
   a. all temperatures to °C.
   b. all pressures to millibars.
   c. if conversion tables not available, enter values as observed, followed by letters or abbreviations for the first entry on each form, ("77.5°F", "29.905 in.", etc.)
4. Begin a new sheet each month, voyage, ocean and quadrant.
5. Transmit data in 5-figure groups from unshaded columns and remarks. See observing handbook, section 1-04 for handling missing data.

IND.	LATITUDE (Degrees and tenths, 3 figures)	QUADRANT OF GLOBE	LONGITUDE (Degrees and tenths, 4 figures)	DAY OF MONTH GMT (2 figures)	TIME GMT (2 figures)	WIND INDICATOR (Coded)	TOTAL CLOUD AMT.	WIND: DIRECTION ((True) tens of degrees (00 = calm))	WIND: SPEED (True knots)	VISIBILITY (Coded 90 - 99)	PRESENT WEATHER (Coded 00 - 99)	PAST WEATHER (0 - 9)	SEA LEVEL PRESSURE (Millibars and tenths. Last 3 figures in Col. 15 and first "9" or "10" in Col. 14)		AIR-TEMP. DATA °C: DRY BULB (Degrees in Col. 16, tenths in Col. 17 & 33)	AIR-TEMP. DATA °C: WET BULB (Degrees and tenths)		AMOUNT OF LOWEST CLOUDS	TYPE OF LOW CLOUD	HEIGHT OF LOWEST CLOUDS	TYPE OF MIDDLE CLOUD	TYPE OF HIGH CLOUD	COURSE OF SHIP (Coded 0 - 9)	SPEED OF SHIP (Coded 0 - 9)	3-HOUR PRESS. CHANGE: CHARACTER OF CHANGE	3-HOUR PRESS. CHANGE: AMOUNT OF CHANGE (Mb and tenths)	INDICATOR	AIR-SEA TEMP. DIFFERENCE (Coded)	DEW POINT FROM TABLE 30	INDICATOR	SEA TEMPERATURE °C (Degrees and tenths 3 figures) CHECK ONE ☐ BUCKET ☐ INTAKE	TENTHS OF AIR TEMP.	INDICATOR	WAVES (Make as many groups as patterns observed) WIND WAVES: PERIOD (Avg. seconds 2 figures)	WIND WAVES: HEIGHT (Coded)	SWELL: DIRECTION (tens of degrees)	SWELL: PERIOD (Coded)	SWELL: HEIGHT (Coded)	ADDITIONAL MESSAGE GROUPS AND REMARKS (More swell groups, 2 $I_sE_sE_sR_s$, ICE C_2KD_ire, Wind Shifts, beginning and ending of precip., freak waves, etc.)	CHECK IF SENT BY RADIO / OBSERVERS INITIALS
1	2	3	4	5	6	7	8	9	10	11	12	13		15	16			19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
99	$L_aL_aL_a$	Q_c	$L_oL_oL_oL_o$	YY	GG	i_w	N	dd	ff	VV	ww	W		PPP	TT			N_h	C_L	h	C_M	C_H	D_s	v_s	a	pp	0	T_sT_s	T_dT_d	1	$T_wT_wT_w$	t_T	3	P_wP_w	H_wH_w	d_wd_w	P_w	H_wH_w	–	–
99					00																						0	//		1			3							
99					06																						0	//		1			3							
99					12																						0	//		1			3							
99					18																						0	//		1			3							
99					00																						0	//		1			3							
99					06																						0	//		1			3							
99					12																						0	//		1			3							
99					18																						0	//		1			3							
99					00																						0	//		1			3							
99					06																						0	//		1			3							
99					00																						0	//		1			3							
99					18																						0	//		1			3							
99					00																						0	//		1			3							
99					06																						0	//		1			3							
99					12																						0	//		1			3							
99					18																						0	//		1			3							
99	$L_aL_aL_a$	Q_c	$L_oL_oL_oL_o$	YY	GG	i_w	N	dd	ff	VV	ww	W		PPP	TT			N_h	C_L	h	C_M	C_H	D_s	v_s	a	pp	0	T_sT_s	T_dT_d	1	$T_wT_wT_w$	t_T	3	P_wP_w	H_wH_w	d_wd_w	P_w	H_wH_w		

NOAA FORM 72-1 SUPERSEDES ESSA FORM 72-1 WHICH MAY BE USED

Figure 18.--Sample copy of cooperative "Ship's Weather Observations" log. (NOAA Form 72-1)

Tips to the Radio Officer

Warren D. Hight
National Weather Service, NOAA
Silver Spring, Md.

CORRECTION TO PUBLICATION U.S. AND FOREIGN COASTAL RADIO STATIONS ACCEPTING SHIPS WEATHER OBSERVATION MESSAGES

Page 5

(a) Station NMF, Boston, Mass.: Amend to read "472, 8728, 12934.5, 22487.5"
(b) Station NMG, New Orleans, La.: Delete "8710 kHz"
(c) Station NMN, Norfolk, Va.: Amend to read "466, 8465, 17151.2"

Page 6

(a) Station NMQ, Long Beach, Calif.: Delete "8728 kHz"
(b) Station NMC, San Francisco, Calif.: Add frequencies "17218.4 and 22476 kHz"

Note: U.S. Coast Guard Radio Station NMQ, Long Beach, discontinued guarding the 8 MHz band on February 1, 1973; Radio NMC, San Francisco, will answer all calls directed to Radio NMQ on the 8 MHz band.

COAST GUARD RADIO STATION NMC, SAN FRANCISCO (PT. REYES), RADIOFACSIMILE BROADCAST

In the January issue of this publication, this column contained details of the new marine weather broadcasts by Coast Guard Radio NMC. The schedule of the radiofacsimile transmissions times were erroneously listed as "0530" and "1730 GMT." It should be corrected to read "0945" and "2145."

ACKNOWLEDGEMENT

We would like to take this opportunity to thank H. Ronquillo, Radio Officer on the SS COPPER STATE, for sending information for use in updating our publication, Weather Service for Merchant Shipping.

On the Editor's Desk

INTENSIVE STUDY OF SOUTHEAST COASTAL ZONE LAUNCHED BY NOAA

A concentrated 2-yr environmental study from the air, sea, and land was launched in January in a 105,000-sq. mi area of coastal waters off northern Florida, Georgia, and South and North Carolina by NOAA.

Four ships, a plane, a hydrographic field party, and land support units will carry out the program in coastal waters extending from Cape Hatteras, N.C., to the vicinity of Cape Kennedy, Fla., and out to sea as much as 300 mi. The water depths being surveyed range from the surf zone area to 16,000 ft at sea.

The study of the southeastern coast of the United States, dubbed Project SCOPE for Southern Coastal Plains Expedition, is designed to compress within 2 yr, projects which had previously been programmed for the next 12 to 15 yr. Similar concentrated studies are being planned for other east coast areas after the present survey is completed.

The study, being carried out by NOAA's National Ocean Survey, is a scientific and fact-finding program which combines the resources of NOAA and academic, regional, and state agencies in solving environmental problems in the coastal zone. The expedition is designed to provide coastal zone planners with data which will enable them to predict the consequences of both nature's and man's activities in these areas. Complete processing of the data will be accomplished in about a year, following completion of the field work, some of it while field work is still under way.

Among the important aspects of the study will be obtaining data enabling planners to cope better with coastal water pollution, and to determine State and Federal seaward boundaries. From aerial photography of the coastline, photos will be available to coastal zone managers preparing base maps for delineating coastal zone activities. In southern Georgia, new aerial photography will be used to delineate the mean low water line (the Federal boundary) and the mean high water line (the State boundary). Recent photography will be used in all other shore areas.

SCOPE will involve, in addition to aerial photography of the coastline, surveys of the sea bottom's topography, charting of the coastal waters, tidal current and tidal surveys, and studies of the sea's physical properties, such as salt content and temperature of the water, and delineation of the Gulf Stream.

Participating in the study will be the NOAA Ship MT MITCHELL, which will travel some 25,000 mi while conducting hydrographic surveys in an area 60 to 200 mi wide extending out to sea from 600-ft depths off Florida, Georgia, and the Carolinas. The NOAA Ships PEIRCE and WHITING, which will carry out inshore marine charting surveys to the 660-ft depths; PEIRCE off Florida, Georgia, and South Carolina and WHITING off North Carolina. The NOAA Ship FERREL will carry out tidal current surveys off North Carolina, South Carolina, and Georgia. The ships are based in Norfolk, Va.

A hydrographic field party, employing a high-speed launch capable of conducting marine surveys at up to 20 kt, will work off Georgia from depths of 10 to about 60 ft. Landbased parties will assist marine charting by locating sites for electronic control stations, establishing tide gages, and checking prominent landmarks for other navigation controls.

METEOROLOGICAL OBSERVATIONS BY VOLUNTARY OBSERVING SHIPS FOR CINECA

The World Meteorological Organization has requested assistance in obtaining meteorological observations for an oceanographic investigation named CINECA (Cooperative Investigation of the Northern Part of the Central Atlantic). During February, March, and August 1973, oceanographic surveys will be undertaken by research vessels in the sea area off the African west coast, roughly between 20° and 30°N. The purpose of CINECA is to investigate the circulation and composition of ocean water where it wells up from great depths in the area off this coast. The upwelling cold water masses are rich in nutrients, and the circulation is of great importance to fisheries. The process of upwelling is strongly dependent on wind conditions over a much larger area, and it is for this reason that meteorological observations are needed from as many ships as possible during the survey periods.

Requirements for meteorological observations

Ocean area: Between 10°N and 36°N, from the African west coast to longitude 30°W (fig. 19).

Periods: First period: January 15-April 15, 1973
Second period: July 15-September 15, 1973

Time of observation: 00, 06, 12 and 18 GMT

Ships: All ships traversing the area are requested to participate.

Observations:

(a) Ships taking part as SELECTED SHIP in the WMO voluntary observing ship scheme are requested to transmit their meteorological observations to one of the coastal radio stations listed in table 5.

(b) Other ships wishing to participate are requested to observe and report:
- wind direction, in tens of degrees
- wind speed, with indication whether reported in Beaufort number, knots, or m/sec
- air pressure, in tenths of mb
- air temperature, in whole degrees C
- sea surface temperature, in whole degree C

Note: The barometer should be read at a time as near as possible to the exact time of observation.

Transmission of observations

The meteorological observations should be transmitted as soon as possible to the nearest coastal radio station accepting ships' weather reports (table 5). During the preparatory phase of the investigation, it was also found that data disseminated by Dakar via the transmitters GVY and/or GVA can easily be heard by mobile ship stations aboard oceanographic research vessels working in the CINECA area.

Log sheets

SELECTED SHIPS are requested to send a copy of the log sheets of the meteorological observations taken during each one of the two periods, January 15-April 15, 1973, and July 15-September 15, 1973, to the following address:

Secretary-General
International Council for the Exploration of the Sea
Charlottenlund Castle
DK-2920 Charlottenlund
DENMARK

Figure 19.--Area for which marine meteorological observations are required for CINECA.

Table 5.--Radio stations accepting ship's weather reports for CINECA project.

Name of the Station and country	Location	Call sign	Receiving frequencies (kHz) Transmitting frequencies (kHz) Watch	Working	Watch	Working	Hours of operation	Radio address of meteorological centers
Gibraltar GIBRALTAR	36°09'N 05°20'W	ZBM	500	468 on frequency advised by ship	500	464	0H 00-24	METEO Gibraltar
Tanger Radio MOROCCO	35°46'N 05°49'W	CNN	500 2182	On request	500	447 1911 2635	00-24	METEO Tanger
Casablanca Radio MOROCCO	33°37'N 07°38'W	CNP	500	On request	500	441	00-24	METEO Casablanca
Funchal MADEIRA (PORTUGAL)	32°38'N 16°54'W	CTR	500	500	410	480	00-24	METEOLISB
Safi Radio MOROCCO	32°18'N 09°15'W	CND	2182	On request	2182	1743 2628	00-24	METEO Safi
Agadir Radio MOROCCO	30°22'N 09°33'W	CNO	500 2182	On request	500 2182	441 1911, 2992	00-24	METEO Agadir
Tenerife CANARY ISLANDS (SPAIN)	28°21'N 16°17'W	EAT	500		500	472, 418	00-24	METEO Madrid
Las Palmas CANARY ISLANDS (SPAIN)	28°07'N 15°25'W	EAL	500		500	418, 418	00-24	METEO Madrid
Port Etienne Radio MAURITANIA	20°54'N 17°03'W	STA 1/3/2	500		500	488, 518	08-22	METEO Port Etienne
Dakar Radio SENEGAL	14°45'N 17°13'W	6 VA	500	425, 454 480, 512	500	416	00-24	METEO Dakar Yoff

Other ships participating are requested to enter their meteorological observations on the log sheets supplied by the Port Meteorological Officer and send these to the address mentioned above.

Your observations will be highly appreciated.

NATIONAL WEATHER SERVICE AND COAST GUARD EXPAND GREAT LAKES ICE FORECASTING

The National Weather Service (NWS), in cooperation with the U.S. Coast Guard, is expanding its ice-forecasting service for commercial shipping on the Great Lakes.

The effort is part of the Demonstration Program to Extend the Shipping Season on the Great Lakes and St. Lawrence Seaway, under the general management of the Army Corps of Engineers. NOAA and a number of other agencies, both public and private, are participating in the program--now in its second year--aimed at lengthening the navigation season on the Great Lakes during the winter months.

Traditionally, ice has blocked passage of ore boats and other large vessels on the lakes for periods of 2 to 3 mo each winter. Officials believe faster and more-detailed weather reports will help commercial skippers keep going longer.

As one part of the ice-forecasting expansion, NWS this year has assigned one of its meteorologists fulltime to the Coast Guard Ice Navigation Center at Cleveland. His work will supplement that of the main Great Lakes Ice Forecasting Center at the National Weather Service Forecast Office in Detroit.

The Cleveland center will be equipped with regular Weather Service teletypewriters and facsimile equipment so that personnel there will have available the latest weather observations and forecasts for briefings and chart information to relay to shipping agents and vessel captains.

The main ice-forecasting unit at the weather office in Detroit is expanding its service to issue ice and weather reports twice a day, instead of once a day--an ice outlook issued at 1540 will give mariners general information extending over the next several days; and an ice forecast will provide more specific information for a period ending at 2400 the following day. Both will be available from Coast Guard radio stations around the Great Lakes.

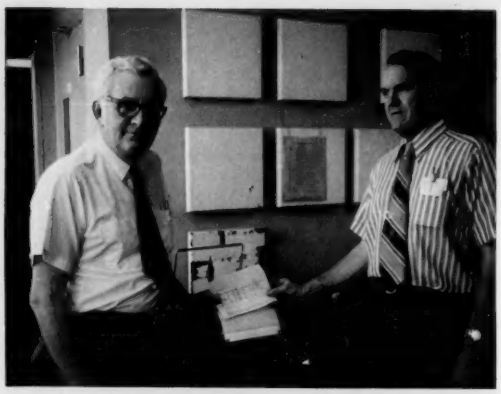

Figure 20.--Port Meteorological Officer William E. Kennedy handing the first message to come over the new marine teletype system, which was a ship observation from the ARTHUR M. ANDERSON to Richard Fay, Meteorologist in Charge of the Cleveland Weather Service Forecast Office.

NEW MARINE TELETYPE SYSTEM COMMISSIONED ON GREAT LAKES

A new marine teletype system for the Great Lakes was commissioned at 1300 EST on January 16, 1973. The first ship report (fig. 20) was from the Marine Radio Station, WLC, Rogers City, Mich. and came from the ARTHUR M. ANDERSON. Three ship reports followed shortly after from the A.H. FERBERT, LEON FRASER, and the ENDERS M. VOOHREES. It was within seconds from the time the ship called the radio station to the time the message was received at the three National Weather Service Forecast Offices (WSFO) at Chicago, Detroit and Cleveland, and the Ice Control Center at the Ninth District Coast Guard Headquarters in Cleveland.

The new system links together the three forecast offices at Cleveland, Detroit and Chicago who are responsible for the lakes' forecasts and warnings, the forecast office at Buffalo and the Weather Service Offices at Milwaukee and Duluth. Also in the system, are the Ninth District Coast Guard Headquarters; the Canadian forecast office at Toronto, Canada; and the Marine Radio Stations at Lorain, Ohio (WMI), Buffalo, N.Y. (WBL), Rogers City, Mich. (WLC), Port Washington, Wis. (WAD), Chicago, Ill. (WAY) and Duluth, Minn. (WAS).

Where previously a special marine warning frequently had multihandling, it is now received simultaneously at each marine radio station and at Coast Guard Headquarters. Special ship reports are received within seconds after being sent by a vessel. Warnings may be issued and broadcast almost immediately after receiving a special report of gale- or storm-force winds or other hazardous conditions.

The system will be monitored by WSFO Cleveland, and is an important tool for the Great Lakes Ice Forecaster stationed at the Ninth District Coast Guard Headquarters in Cleveland, in support of the extended navigation season on the Great Lakes.

COAST GUARD TRACKING ICEBERGS EARLIER THIS YEAR

An abnormally large number of icebergs off Newfoundland's east coast--65 of them--are threatening major North Atlantic shipping routes and caused the Coast Guard to begin its program of tracking them and broadcasting their position on January 24--more than a month earlier than usual.

Icebergs were found near the Grand Banks region during the aerial flight early in January. The Coast Guard's International Ice Patrol at Governors Island became concerned because no bergs have been found in this area so early in the year for the past 10 yr.

The icebergs were detected at the 50th parallel and the region northward up to the 67th parallel contains the normal number of icebergs expected for this time of the season. Icebergs that drift below the 48th parallel (fig. 21) become especially dangerous to shipping.

Last year was the heaviest season since the Patrol began almost 60 yr ago. Some 1,600 bergs forced shipping to move considerably south of the normal traffic lanes for safety.

The number of bergs "calved" off the West Greenland glaciers varies from year to year. How many of them reach the shipping lanes after nearly a 2-yr,

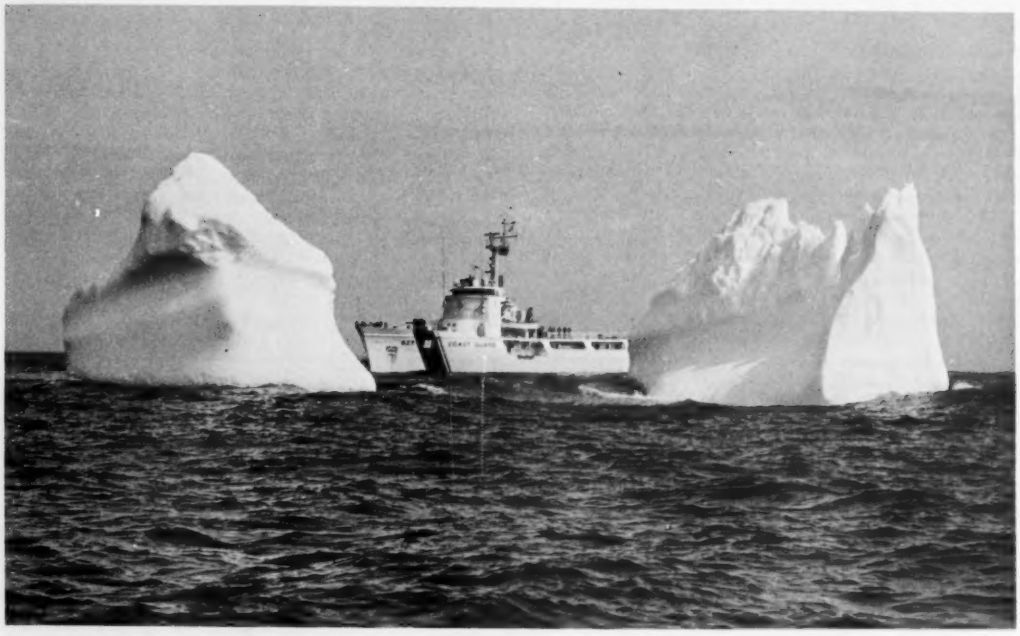

Figure 21.--The USCGC VIGOROUS is framed in the jaws of a twin-peaked iceberg in the North Atlantic shipping lanes. Normally, the Ice Patrol is carried out by Coast Guard planes off the Grand Banks off Newfoundland. Only when there is a heavy concentration of icebergs threatening shipping lanes are cutters called out for standby to warn ships.

1,800-mi trip depends upon weather and oceanographic variables. A season of predominantly northwesterly winds will move more bergs southward. A season marked with easterly winds will drive a number of bergs aground before reaching the Grand Banks.

On the survey in early January, one berg was found about 400 mi east of Newfoundland. This indicated that northwesterly winds prevailed. The bergs that do move below the 48th parallel begin to hit warmer air and water temperatures. From then on, their life span is shortened to a matter of weeks or even days.

Coast Guard aircraft normally based at Elizabeth City, N.C., will be flying ice observation flights out of the Canadian forces base at Summerside, Prince Edward Island. The information from these patrols, along with sightings of icebergs reported by ships and other aircraft, will be passed to International Ice Patrol headquarters. This data will be fed into a computer, along with ocean current and weather information every 12 hr. Then, the predicted position of the bergs will be transmitted twice daily from radio stations in the United States and Canada.

International Ice Patrol operations began 1 yr after the tragic sinking of the British luxury liner TITANIC in April 1912, when it struck an iceberg some 300 mi southwest of Newfoundland, with the loss of more than 1,500 lives.

The Coast Guard carries out the yearly surveillance of icebergs. The cost of the operation is shared by 18 other maritime nations, proportionate to the amount of their shipping passing through the ice-endangered sea lanes.

CASUALTIES ABOARD U.S. COMMERCIAL VESSELS

A total of 4,117 ships were involved in 2,424 joint casualties during the year ending June 30, 1972, according to a tabulation contained in a recent issue of the Proceedings of the Marine Safety Council. Storms or adverse weather were the primary cause of 256 of the 4,117 individual casualties, and unusual currents were the primary cause of 14 of these casualties. There were 177 deaths and 110 injuries as a result of 125 ship casualties; four of these casualties were the result of collisions in fog while none were due to heavy weather damage.

In addition to the above deaths and injuries, there were 348 deaths and 1,243 injuries aboard ships not involved in ship casualties. Natural causes accounted for 147 of these deaths; 100 persons fell overboard and drowned, and only 7 deaths were primarily attributed to weather conditions (5 fell overboard). Sixty-nine of the injuries were a direct result of weather.

Casualties involving commercial vessels are required to be reported to the U.S. Coast Guard whenever the casualty results in 1) actual physical damage to property in excess of $1,500, 2) material damage affecting the seaworthiness or efficiency of a vessel, 3) stranding or grounding, 4) loss of life, and 5) injury causing any person to remain incapacitated for a period in excess of 72 hr, except injury to harbor workers not resulting in death and not resulting from vessel casualty or vessel equipment casualty.

PUBLICATIONS OF INTEREST TO MARINERS

MARINE CLIMATOLOGICAL SUMMARIES

The first issue of Marine Climatological Summaries, Volume 4, 1964, for the U.S. area of responsibility in a cooperative World Meteorological Organization Program was published in January 1973. The area covered and the Representative Ocean Areas and Ocean Weather Stations for which summaries were prepared are shown in figure 22.

The elements summarized are: dry-bulb temperature, dew-point temperature, sea temperature, air-sea temperature difference, visibility, weather, wind direction and speed, pressure, cloud, and waves. The data are presented in tables by month, giving frequency of occurrence for Representative Areas and percent frequency for Ocean Weather Stations.

The summaries were published by and can be obtained from the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Center, Federal Building, Asheville, N.C. 28801. The price is $5.00 domestic and $6.25 foreign.

Other Marine Climatological Summaries that have been published to date are:

Atlantic Ocean, east of 50°W and north of 20°N, Vol. 4; Her Majesty's Stationary Office.
Mediterranean and Southern Indian Ocean, Vol. 4; De Bilt, Netherlands.
Pacific Ocean, 00 to 46°N, 120°E to 170°W, Vol. 4 and Vol. 5; Japan Meteorological Agency.

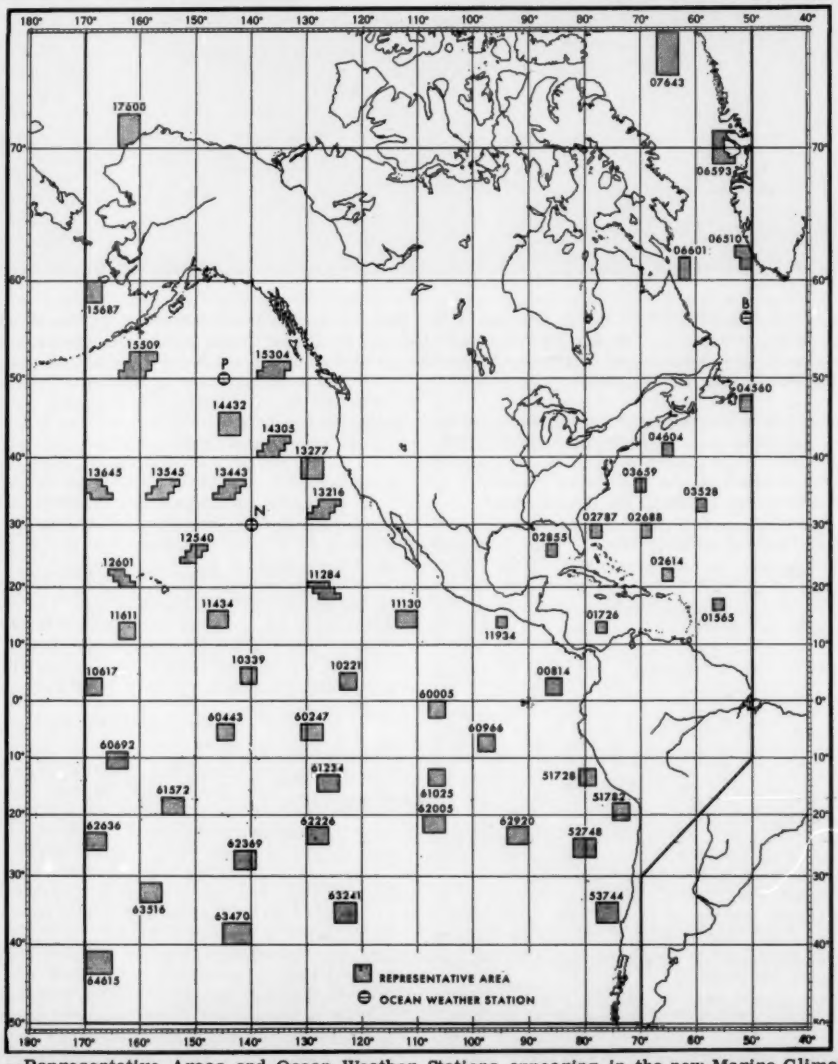

Figure 22.--Representative Areas and Ocean Weather Stations appearing in the new Marine Climatological Summaries for the U.S. area of responsibility.

LETTERS TO THE EDITOR

HISTORIC LETTER ESTABLISHING MARINE PROGRAM AT NEW ORLEANS

The Marine Supervisor, A. J. Rolfs, at New Orleans forwarded an historic letter (fig. 23) he thought would be of interest to our readers. It established a marine meteorological data program at New Orleans, La. It is dated January 23, 1873, and directs the Signal Service Observer in New Orleans to contact every arriving vessel for permission to transcribe all meteorological data from the ships' log.

The Mariners Weather Log would be very interested in obtaining any other old documents of this type, to include in the publication. Glossy prints or negatives are fine, but if not available, we will have prints made and return the original.

WAR DEPARTMENT,

Office of the Chief Signal Officer,

DIVISION OF

TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE AND AGRICULTURE,

Washington, D. C. January 23d 1873

Sergt Frank Mansfield
Observer Signal Service U.S.A.
New Orleans La.

Sergeant.

The Chief Signal Officer directs that you will apply to the Commanding Officer of every vessel arriving at your Station for permission to transcribe from the Log of such vessel all meteorological data contained therein. When such transcript is made, be careful to note the Latitude and Longitude of each observation. It is probable that in most cases this transcript will be cheerfully furnished by the officer, when it is understood, that it is the request of the Chief Signal Officer. When this is done it will save you considerable labor.

Very respectfully &c

[illegible]

2d Lt 24th Inf Capt U.S.A.
A.S.O. & Asst

Figure 23. --Letter authorizing the marine program at New Orleans over 100 yr ago.

KETCH STORM BATTLES STORM

The following letter was written by R. S. Davidson. He was one of four men aboard the ketch STORM, which was caught by the same high winds and seas that forced the tug CAROLYN to take refuge in Chesapeake Bay. The barge she was towing broke loose and crashed into the bridge, knocking it out in two places. For a description of this storm, see the September Smooth Log on page 89.

"In your Mariners Weather Log, Vol. 16, No. 6, page 402, you describe a storm that moved off the Virginia coast on the 19th. The report of 40-kt gales and 30-ft seas, from the BOSTON, was particularly interesting. At that time, I was within a few miles of her position, with three friends, in a 35-ft cutter-rigged ketch named STORM--the name was certainly apt. Her design is similar to a double-ended Norwegian lifeboat.

"With her owner, Howard Duplessis, we left our home port of Deep River, near the mouth of the Connecticut River on Monday, September 18. By the afternoon of Tuesday, we passed out of New York Harbor headed for the Delaware River and Chesapeake Bay. The forecast was for clearing northwesterly winds which would have been fine for our passage. At the time we passed Sandy Hook, through the Swash Channel, there were whitecaps and about 20-kt winds from the north.

"The wind strengthened from the same direction, which was directly aft as we headed south. Just as we were about to shorten sail, a sea picked up our stern and swung it around, causing us to jibe and break our boom against the weather backstay.

"I would like to assure you that the STORM is a fine ship of the most seaworthy design. She is similar to the famous Norwegian sailing lifeboats designed by Colin Archer. She was 12 yr building and was finished in 1969. Everything about her was seaworthy as was proven in the events that followed.

"We could not use our mainsail, because of the broken boom. Howard and Phil Plumb reefed our staysail to a triangle about 4 ft on the foot and 8 ft on the hoist. This was our only sail for the rest of the trip--resulting in the grounding. We could only angle downwind from now on.

"The rising wind shifted slowly into the northeast, where it held, fortunately. We headed southeastward all night, crossing the traffic lanes and seeing fewer and fewer ships passing in the rising storm. The waves occasionally slopped into the cockpit, but it was small and self bailing. Howard and I stayed on deck, taking turns at the helm. The next morning, the 20th, the wind was howling, and the waves were long and sweeping with breaking crests and long sweeps of foam down their faces. They seemed to pass us at about 45 kt. At this time, we estimated our

Figure 24.--Heavy equipment helps the yacht STORM get back to its natural environment. Photo courtesy of Assateague Island National Seashore.

Figure 25.--With a taut line around her hull, STORM is about to be refloated. Photo courtesy of Assateague Island National Seashore.

speed at 3 5 kt. We failed to be aware of the surface movement of an additional 4 kt to the south, created by the storm.

"Our path during the night took us about 50 mi offshore. This was done to give us offing in case the wind continued to swing into the east. However, the wind held in the northeast, so we began to angle inshore to try and get into the mouth of the Delaware and find a lee shore anchorage.

"About noon we sighted a navigational aid. It was the only one we saw on the entire trip. Our radio direction finder developed so much static that it was inoperable. In addition to this, the waves were so high that we could not see a buoy, unless it was very close. The buoy we came upon was a giant sea buoy marked "F." No such buoy showed on our chart. We later found that this was the new Five Fathom Shoal marker that replaced the lightship that was on our chart. We thought this buoy must be farther north, close to our estimated position, among a group of buoys marked "FA," "FB," etc.

"Therefore, we continued to angle inshore to the southwest, not realizing that a more westerly course (which we could have laid) would have taken us to the Delaware Breakwater at Cape Henlopen.

"At dusk, we closed the shore in huge waves and screaming wind. We wrongly identified the Indian River inlet bridge as the bridge at Hereford Inlet. We paralleled the shore, thinking that we would soon round Cape May.

"We identified Ocean City as Cape May and closed the Jetty entrance to find giant seas sweeping right over the jetty marker lights. We never saw the light buoys marking the entrance at all. We then headed to round "Cape May" inside the Prissy Wick Shoals. The darkness just south of Ocean City, we identified as the mouth of the Delaware. Instead, the wind and sweeping seas, drove us onto the lonely sands of the National Seashore of Assateague Island, about 1.5 mi south of the Ocean City Inlet.

"We were swept safely up on the sand to a position about 8 ft above the high water mark.

"The Coast Guard 44-footer from Ocean City came out in answer to our flares and after seeing us ashore, they radioed the Park Rangers. The Rangers came to us by dune buggy and took us to the Coast Guard station.

"With the help of many kind townspeople, fishermen, and the local salvage diver, we got the vessel off the beach on the following Sunday (figs. 24-25). Two weeks later, after temporary repairs, we sailed her around to Cambridge, Md., in Chesapeake Bay.

"STORM's repairs were finished in early December and she is in fine shape now. The tremendous strength and fine design brought us through a rough experience that we hope does not occur again, ever! I have crossed the Atlantic as bos'n and first officer of a barquentine in 1971, and never saw anything approaching this 'small LOW' that you describe in the November Log.

"The Mariners Weather Log is a great publication that really helps all of us whose lives depend on ocean weather knowledge."

MARINE WEATHER REVIEW

Smooth Log, North Atlantic Weather

September and October 1972

The SMOOTH LOG (complete with cyclone tracks [figs 28-31], climatological data from U. S. Ocean Station Vessels [tables 6-10, 12] and gale tables 11, and 13, is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

SMOOTH LOG, SEPTEMBER 1972--The Bermuda High (1020 mb), as usual, dominated the North Atlantic during the month of September. From the east coast of the United States, eastward to the west coast of Africa and Portugal, the subtropical High was near normal in configuration and pressure. A major anomaly occurred just west of Ireland near 57°N, 12°W, with pressures averaging 11 mb above normal. The central pressure of this maverick high-pressure area was 4 mb greater than the Bermuda High, on the average. As a result of this blocking High, the storm tracks were diverted northwestward through the Denmark Strait, between Greenland and Iceland. This resulted in beautiful weather for all of western Europe. A second major storm track crossed Lake Winnipeg in south-central Canada northeastward into the Hudson Bay area where it dissipated. A few relatively weak frontal waves managed to penetrate the ridge of high pressure extending northeastward from the Bermuda-Azores High and approach the area west of the Strait of Gibraltar. The pressure over the Great Lakes was slightly (1 mb) above normal (1017 mb). Two relatively weak low-pressure centers crossed the lakes. The Icelandic Low normally centered in the Davis Strait was split into two centers, one (1007-mb) near the tip of Greenland, and the other (1006-mb) over northern Hudson Bay. A third low center was well northeast of Iceland at 75°N, 5°E.

Only one named tropical cyclone, hurricane Dawn, occurred during September. Dawn generated into a tropical depression in the Florida Straits on the 4th, developed hurricane force on the 7th, and wandered off the U. S. East Coast until the 14th--dying on the coast of Georgia. A description of Dawn appears in the article "North Atlantic Tropical Cyclones, 1972" which was published in the January 1973 issue of the Mariners Weather Log.

September can be noted for the lack of storm tracks, other than those passing into the Davis Strait and Denmark Strait areas. Only two systems crossed the North Atlantic from near the U.S. East Coast into the European continent. Both of these were originally tropical cyclones--hurricane Betty and tropical storm Carrie. What must be one of the deepest storms recorded in September--other than tropical cyclones--occurred with a central pressure of 950 mb in the vicinity of 58°N, 37°W, on the 22d. On the 20th and 21st, it was identified as subtropical storm Charlie. Other storms were generally weak, deepening when first moving over open water, but filling rapidly after a day or two as they moved north and east and encountered the high-pressure ridge west of the European land mass.

Beginning on the 2d, two small waves formed on a cold front extending southwestward from former hurricane Betty. The low-pressure center that was formerly Betty remained quasi-stationary near 45°N, 40°W, as these waves appeared to reinforce her strength. The NEWFOUNDLAND reported 40-kt winds near the LOW, and other ships reported up to 45 kt. On the 5th, a LOW developed on the cold front near 33°N, 47°W, and the VATUTINO was buffeted by 45-kt gales. In the warm sector, three other vessels, including the MINERVA, experienced 35-kt winds and seas running as high as 12 ft. On the 6th, the two LOWS (993 mb) converged and started moving eastward. On the 6th and 7th, various ships reported 35-kt gales, including Ocean Station Vessel "D." As the storm pushed through the high-pressure ridge extending northeastward from the Azores High, it weakened rapidly. The front entered the coast of France on the 9th with only a trough remaining as evidence of former hurricane Betty.

A weak LOW which was over British Columbia on the 4th tracked slowly across southern Canada. On the 6th, an infusion of fresh energy resulted in a more organized circulation just south of Lake Winnipeg. A front extended east-west across the continent through its center. At 0000 on the 7th, the 988-mb low center was north of Lake Superior, with the warm front lying southeastward across the lake. The JOHN DYKSTRA, about 30 mi northeast of Marquette, measured 52-kt winds and 6.5-ft seas. The weather reported was "02," sky unchanged for the last hour. The LOW continued to track northeastward and dissipated into a trough near Frobisher Island on the 8th.

A diffuse low-pressure area existed over Newfoundland on the 7th. It deepened as it moved over the water and by the 9th was a closed system (1005 mb). The KATSEDYK and MADAKET were caught in 35-kt easterly winds with waves up to 6 ft and swells as high as 12 ft. The LOW (1000 mb) continued to survive as it drifted slowly eastward in an attempt to penetrate the ever-present ridge. On the 11th, the FRANCE was hampered by 40-kt gales and 11-ft swells out of the

east. The persistent ridge of high pressure finally won the battle, and the storm gradually filled and drifted in the area of the Azores Islands until the 17th. This was the farthest east and south any extratropical storm penetrated during the month.

As tropical storm Dawn curved westward and then southward off Cape Hatteras on the 10th, a portion of the low-pressure area broke away in association with a frontal system moving off the coast. The LOW moved rapidly northeastward while deepening. By 1200 on the 11th, the center (982-mb) was near Argentia, Newfoundland. The Coast Guard Cutter HAMILTON and the NEWFOUNDLAND COAST fought 40-kt winds and 15-ft waves near 45°N, 55°W. On the 12th, the HAMILTON was still battling the 40-kt winds and high seas. The storm continued moving almost due northward with exposed coastal stations reporting high winds. The storm center settled near Frobisher Bay on the 13th with several stations reporting snow with light winds as the gradient decreased.

Meanwhile, on the 12th, a wave was forming in the midwestern United States on a weak east-west frontal system. The storm gradually deepened as it moved across the Great Lakes and up the St. Lawrence River on the 13th and 14th. By the 15th, the system, with a central pressure of 980 mb, was off the Labrador coast and raising havoc with the NORMANNIA at 44°N, 48°W, and other ships farther north. Winds were blowing at 45 kt, and 18-ft waves were encountered. On the 16th, the storm continued northward, pounding the ALEXANDR IVANOV, the FLORISTAN, the NICOLAS BOWATER, Ocean Station Vessel "C," and Kap Farvel with 35- to 45-kt gales and waves as high as 30 ft. As the storm passed up the Denmark Strait on the 17th, it quickly lost its punch.

A storm that was already down to 984-mb came roaring across Canada, and on the 18th, crossed the coast north of Goose Bay, Labrador. Prior to crossing into open waters, the tight gradient produced 35-kt winds which made it uncomfortable aboard the D'IBERVILLE, which was proceeding southward to a better climate. Hopedale, on the coast, battened down for 45-kt winds but didn't have to contend with the 15-ft waves. As the center passed north of Ocean Station Vessel "B" and across Kap Farvel on the 19th, the weather ship was pounded by 60-kt winds and waves of 15 ft. The D'IBERVILLE continued to be lashed by 35-kt gales and the same high seas as "B." The CONSTANCE BOWATER was suffering the same fate near 55°N, 44°W. All the ships got a good washing down with the heavy rains that accompanied the severe winds. At this point, the forward motion to the northeast slowed and the pressure gradient remained steady. The DUHALLOW reported 50-kt gales at 59°N, 38°W, and swells of over 20 ft on the 20th. By the 21st, as the LOW (986-mb) passed over Iceland, the center had begun to fill and pick up forward speed toward the northeast, where it combined with a stationary LOW above 70°N, 5°E.

A freak storm on the 21st helped cause havoc with the Chesapeake Bay Bridge and Tunnel connecting Cape Henry and Cape Charles, Va. The bridge was knocked out in two places as 60-ft-long sections collapsed when a barge under tow by the tug CAROLYN broke loose and crashed into the bridge (fig. 26). The barge came to rest on the shore at Cape Henry. The bridge

Figure 26. --Empty barge batters trestle structure of the Chesapeake Bay Bridge Tunnel complex after chewing thru half the roadway of one span. The barge went adrift from the tug CAROLYN in heavy seas and strong winds on September 21, 1972. Wide World Photo.

remained closed for 2 weeks while the barge was removed and temporary repairs made. The tug returned south to take refuge in Chesapeake Bay after encountering 35- to 40-kt winds and 25- to 30-ft seas off Chincoteaque Island on the 20th. After entering the Bay, winds gusting to 50 kt were estimated. Very heavy rains with flooding occurred in the Norfolk-Hampton Roads area.

All of this was the result of a wave which traveled eastward along a front that generally lay parallel to 42°N across the eastern half of the United States, on the 18th and 19th. On the 19th, a small LOW moved offshore in a southerly direction with a cold front passing Norfolk, Va., prior to 0000 on the 20th. On the 20th, the BOSTON reported 40-kt gales and 30-ft seas near 38°N, 74°W, in the cold sector. The LOW (1011-mb) remained essentially stationary, east of Cape Hatteras, N.C., for the next 48 hr, gradually filling and combining with a trough and front that moved off the East Coast on the 22d. The CHARLESTON reported 35-kt winds with 8-ft waves and 18-ft swells at 1200 on the 21st.

A weak front stretched across the northern United States on the 18th. By the 20th, a low-pressure area had organized near Lake Winnipeg with an occluded front southward to near Lake of the Woods. At 0000 on the 21st, the front was oriented north-south across central Lake Superior. Between 1200 on the 20th and 0000 on the 21st, three vessels reported gales between 40 and 45 kt with sea waves from 6.5 to 11.5 ft. They were the ARMCO, the JOHN SHERWIN, and the PAUL H. CARNAHAN. The LOW and front continued tracking northeastward. On the 23d, the original LOW was left behind, east of Hudson Bay, when a new center generated on the front as it moved over the Davis Strait.

Monster of the Month--This North Atlantic storm originated on the same frontal system that resulted in the damage to the Chesapeake Bay Bridge and Tunnel, and the problems for the tug CAROLYN. As the wave and low center moved over water in a southerly direction on the 19th, another low-pressure center developed south of the cold front near 37°N, 60°W. On the 20th, this storm was christened subtropical storm Charlie. By 0000 on the 21st, the LOW had raced to 44°N, 45°W, a distance of 780 mi in 36 hr, for a speed of 22 kt. The front had been drawn into the center of the LOW and the central pressure dropped from 1019 mb to 996 mb for a rate of 4 mb/6 hr. By this time, several ships were reporting 25- to 30-kt winds. Charlie continued to pick up speed, and 24 hr later (0000 on the 22d) it was located at 54.5°N, 35.0°W, and its central pressure was down to 952 mb.

Ocean Station Vessels "C" and "D" had a rough ride, on the 21st and 22d. At 0300 on the 22d, the USCGC CHASE which was at position "C," was pounded by near hurricane-force winds of 62 kt and 35-ft seas. The USCGC DUANE at "D" was buffeted for over 24 hr by winds of up to 52 kt and waves up to 25 ft. Slightly to the northeast, a ship was being rocked by 60-kt gales, while another was pounded by 30-ft waves and awash with continuous heavy rains. South of the LOW and behind the cold front, 40- to 60-kt winds out of the northwest, with accompanying 25- to 30-ft seas, were common. The FINN-LEONHARDT was engulfed by 50-kt gales and 16-ft waves as far as 400 mi southwest of the LOW. Ahead of the cold front in the warm sector, the NEWARK and the GORREDYK were being buffeted by 35- to 45-kt winds and 10- to 15-ft seas. The BREITENSTEIN, EL LOBO, HORNMEER, VITREA, and many other ships that could not be identified at this time by their call letters, were reporting winds in the fresh to whole gale category. To add to their difficulties, the seas were running from 15 to 25 ft. The strongest wind reported by a ship for this storm was 70 kt, by the C.P.VOYAGEUR, near 53°N, 32°W, at 0000 on the 22d. This hurricane-force wind that tossed the VOYAGEUR was recorded approximately 100 mi east of the storm center. Twelve hours later, she was still reporting 50-kt gales. Ocean Station Vessel "C" was having no picnic during this time, as it was hounded by winds over 40 kt and seas up to 25 ft for over 24 hr.

The storm continued to move north with the central pressure (952 mb) steady, but the gradient was even tighter near the center. The center was located at 58°N, 37°W, at 1200 on the 22d. The NANOK S. was being battered by 60-kt winds and 30-ft waves near 58°N, 42°W. Forty- to 60-kt winds were common. Except for the temperature profile and the high-latitude location, the storm had most of the aspects of a hurricane.

By midday on the 23d, the storm had slowed in its rush to the north and started to fill as rapidly as it had intensified. The killing force was another LOW which came roaring out of the wild Canadian North and absorbed the life blood of this monster, leaving only an anemic, subdued trough in the Denmark Strait as evidence of its ever having existed.

Casualties--In addition to the grounding of the tug CAROLYN and the damage to the Chesapeake Bay Bridge, caused by the barge she had in tow, there was one other weather-related accident. The 11,702-ton Cyprian motorship AEGIS WISDOM and the 12,892-ton Italian bulk carrier LIBRA, collided in dense fog off Les Escoumins Pilot Station, in the St. Lawrence River. There were no injuries to either crew.

SMOOTH LOG, OCTOBER 1972--Cyclone activity and storm tracks were mainly concentrated in two areas. The first was across the southern part of Hudson Bay, predominantly James Bay, then eastward and northward up the Davis Strait. The second was up the U.S. East Coast, across Newfoundland, and through the Denmark Strait. A few weak LOWS developed and wandered about the central and eastern North Atlantic above 30°N. One storm tracked across lower Lake Michigan and Lake Erie prior to joining the main storm track up the East Coast.

The Bermuda-Azores High was more circular, rather than its normal elongated configuration, and within 1 mb of its climatological mean of 1022 mb. The center was located about 600 mi northwest of its mean position. The Icelandic Low, which climatologically is split into two Lows, one near Iceland and one in the Davis Strait, appeared as a closed system only in the Davis Strait and as a trough extending from the Pole southwestward to Iceland. The mean pressure of the Low in the Davis Strait was 1002 mb, 1 mb deeper than indicated by climatology. A shallow Low of 1013-mb pressure was noted off the west coast of Portugal. This was the end result of four migratory

LOWS in that area, approximately one each week, three of which developed in the area.

The displacement of the Icelandic Low and northwesterly position of the Bermuda-Azores High resulted in a positive 9-mb anomaly centered near 55°N, 36°W. This ties in directly with the main storm tracks up both coasts of Greenland and a dearth of storm tracks across the Atlantic into Europe. The main negative anomalies were a 5-mb area off the Portuguese coast, another region of 5-mb near Baffin Island, and a 2-mb area in the central Atlantic. The negative 2-mb anomaly in the Atlantic was due to the more nearly circular, rather than the normal elongated, configuration of the Bermuda-Azores High.

October averages two tropical storms, one of which reaches hurricane strength. This month will help decrease that average as none occurred. In the 31-yr period since 1941, this has occurred in only three other years--1959, 1966, and 1970.

The significant storms in the North Atlantic during October were fairly evenly dispersed throughout the month. All were in the northern and western area except one that tracked eastward across the central Atlantic and one that developed off the Spanish coast. The first storm developed as a LOW, from a wave on a cold front, near 50°N, 66°W. The DAWSON reported 40-kt winds from the south and 15-ft seas just off the Labrador coast. Twelve hours later, at 1200 on the 1st, the DAWSON was still battling the high winds and seas, with Ocean Station Vessel "B," on station, being hounded by 40-kt winds as the front passed. As the LOW, now down to 975-mb, traveled up the Davis Strait, another LOW developed at the point of occlusion and took the high road along Greenland's East Coast. As the 988-mb storm passed to the west of Ocean Station Vessel "A" on the 2d, that vessel had howling 40-kt gales and seas of over 20 ft. It seemed this particular storm had a dislike for Ocean Station Vessels.

The storm continued to the northeast for the next 36 hr. Its location, at 1200 on the 3d, was 73°N, 6°W, with a central pressure of 974 mb. At that time, Ocean Station Vessel "M" also reported 40-kt winds. A coastal station at Alesund, Norway, and another on the northeast coast of Greenland, both reported 35-kt gales. The LOW continued to move eastward along 75°N, but it was no longer a threat to shipping.

While the above storm was raging, another LOW was quietly developing near 45°N, 15°W, on the 2d off the northwest corner of Spain. At 1200 on the 2d, the pressure had dropped to 999 mb. During the next 24 hr, the storm drifted southward and deepened. As the gradient tightened, the winds increased, and by 1200 on the 3d, the following ships were reporting 35- and 40-kt gales with seas to 15-ft. They were the BERGEN MARU, CINULIA, FORT FLEUR DEPEE, and TACTICIAN. At 0000 on the 4th, the center had reached its farthest position south and started a northward movement. The JACQUES CARTIER and the FNAW reported 35- and 40-kt winds, respectively, with accompanying 12-ft seas. Ocean Station Vessel "K" was pounded by winds up to 35 kt from all directions as the LOW passed directly over its position. The center continued its drift northward while filling, and was absorbed on the 7th by a system that trekked eastward from the western Atlantic, with a southerly component.

Going back to the first storm described, a series of waves, traveling northeastward, formed on the front. On the 3d, another wave formed just off Newfoundland with a small closed center of 1010 mb. On the 4th, this LOW was moving northeastward, slowly deepening. By 1200 on the 5th, the central pressure was down to 999 mb and the direction of travel had taken a definite southerly component. The QUEEN ELIZABETH 2 reported 35-kt northerly winds near 46°N, 44°W. Several ships were regaled with winds from 35 to 40 kt and seas up to 15 ft on the 6th when the storm center was located near 45°N, 34°W. They were the AMASTRA, CASTILO DE LAMATO, LANGSTONE, NORSE VIKING, SOLON TURMAN, EXPORT AIDE, and Ocean Station Vessel "C." On the 1200 report, Ocean Station Vessel "D" reported she was being rocked by winds of 50 kt and seas of 15 ft. All reports were from vessels to the west or south of the LOW. On the 7th, the winds were a consistent 40 kt in a jet band on the southwest side of the 992-mb LOW. The FUTAMI MARU, NORSE VIKING, and the ASHBANK were harassed as the LOW stopped for a rest. The 15- to 25-ft waves gave little respite to the ships' crews. On the 8th, it moved southeastward and filled to 1006 mb. The deterioration process continued until the 10th, when all identity was lost near the Canary Islands.

The frontal system associated with the two previously described LOWS was very prolific in the generation of significant storms. On the 5th, a portion of the front was stationary along 30°N, extending westward into Northern Florida. An inverted trough developed off the Florida to Carolina coast as the attendant HIGH passed over Nova Scotia. The EDE SOTTORF, at 37.5°N, 63.5°W reported a 35-kt gale. By the 6th, the trough had spawned two LOW centers, with the northerly one down to a pressure of 1003 mb, and located off Cape Hatteras. At 0000 on the 7th, the CARBIDE TEXAS CITY and the EMERILLON reported 35- to 40-kt easterly winds. By 1200 that day, the ATLANTIC CROWN and the DART ATLANTIC had encountered a breezy 35 kt and the AMERICAN ALLIANCE and the RIEDERSTEIN were buffeted by 40-kt gales. The AMERICAN ALLIANCE and the EAGLE, in the vicinity of 39°N, 62°W at 1800, were pounded by 55-kt winds and seas of 20 to 30 ft. The LOW was now speeding up the Atlantic coast with a 987-mb center.

This storm had a different personality than most others, in that the high winds were east of the LOW, ahead of the cold front, and along or north of the warm front. On the 8th, the LOW registered 976 mb and was located over Cape Cod. North of the warm front, the AMERICAN ALLIANCE was bucking 55-kt crosswinds, and the RIEDERSTEIN was heading directly into 50-kt southerlies. The CETRA COLUMBIA, USCGC INGHAM, DART ATLANTIC, FORT TRINITE, and the RIO MANAMO were not exactly enjoying the 35- to 40-kt tempest and 15- to 20-ft seas over a wide area.

The storm raced northward to combine with the major LOW cell in northern Quebec on the 9th, and the strong wind band moved northeastward with the front. The SEDNETH I, a drilling platform, had 40-kt gales and Ocean Station Vessel "B" was plagued by 47-kt gales. Twelve hours later, the drilling rig

SEDCO and Ocean Station Vessel "B" were still being rocked by 35-kt breezes. On the 10th, only the USCGC SPENCER, cruising just south of Greenland, reported gales of 52 kt. The combined system moved north up the Davis Strait on the 11th and 12th, and this spelled its doom.

This LOW caused more than the usual damage and heartaches along the U.S. East Coast. New Jersey and Virginia received heavy rains with attending floods. The Appomattox River rose to its highest level in 32 yr. Winds gusting to 40 kt were common along the Virginia coast. Three small-craft were swamped, capsized, or sank in the Long Island to Cape Cod area with loss of life. All were near shore but were unable to cope with the 35-kt gales and 6- to 10-ft seas.

On the 8th, the ERNEST T. WEIR reported 41-kt winds from the northwest on eastern Lake Superior. The CHARLES M. BEEGHLY experienced 45-kt gales and 10-ft waves, on the 14th, north of Cleveland on Lake Erie. The weather charts indicate that this was soon after the passage of a warm front.

A LOW that developed near Great Slave Lake in Canada moved southeastward and by 1200 on the 16th had incorporated a weak front into its circulation. At that time, the 983-mb center was 310 mi north of Duluth. By 0000 on the 17th, the pressure had dropped to 977 mb and was located near the tip of James Bay. A cold front extended through approximately the center of Lake Huron and Lake Michigan. Between 1800 on the 16th, and 0600 on the 17th, 14 ships reported gales greater than 40 kt. On Lake Superior, the ships included the ARMCO, ASHLAND, CHARLES M. BEEGHLY, ERNEST R. BREECH, LEON FALK JR, A. H. FERBERT, and the RESERVE. The fastest wind was 52 kt by the LEON FALK JR. The BEEGHLY had the highest waves of 16.5 ft. On Lake Huron or near the Straits of Mackinac, the PAUL H. CARNAHAN, LEON FRASER, WILLIAM A. IRVIN, LEHIGH, and the J. L. MAUTHE were troubled by 40-kt or greater winds, with the JOHN SHERWIN battling 52-kt gales. Waves of 11.5 ft were slapping the LEON FRASER. As the LOW moved off to the northeast, then north, the gradient slackened and the LOW died in Baffin Bay on the 22d.

An east-west oriented cold front was located approximately along 33°N off the U.S. East Coast, early on the 19th. By 1200 that day, a 1007-mb LOW had developed off Cape Hatteras. It raced up the east coast and, by 1200 on the 20th, was 100 mi east of Nova Scotia. During this headlong plunge, the PRESIDENT HOOVER near 35°N, 75°W, had heavy rain showers driven by 45-kt winds and, 6 hr later, the USCGC SPENCER, at 43.7°N, 59.2°W, experienced moderate rain, 52-kt winds, and 26-ft seas. The LOW now at 1000-mb pressure was about 400 mi northeast of Newfoundland, at 1200 on the 21st. Twelve hours later, it was picked up in the circulation of the Icelandic Low and, by 1200 on the 22d, it had been completely absorbed.

Monster of the Month--This storm originated on a frontal system that stretched from Norway, southwestward to Cuba. A small cyclonic circulation developed early on the 22d near 26°N, 64°W. At 0000 on the 23d, the area of low pressure had expanded with three small LOWS. By 1200 that day, the northernmost LOW center (37°N, 53°W) started moving northeastward as a wave on the front, leaving a large area of low pressure behind, located near 30°N, 61°W, at 1540. The LOW continued to travel northeastward along the front for the next 24 hr. At 1200 on the 24th, the LOW had consolidated and attained a central pressure of 1006 mb near 44°N, 43°W. Ocean Station Vessel "D" experienced a breezy 35 kt. Twenty-four hours later, the NORSE VIKING and the JOSEF STEWING were hit by 35-kt gales. At 0000 on the 26th, the LOW had sped to 53.5°N, 23.5°W, with a pressure of 973 mb. She was really wrapping up. Ocean Station Vessels "C" and "J," and the KRASNOKAMSK relayed 35-kt gales. The ENISEILES was pounded by 50-kt winds and 25-ft seas near 49.1°N, 23.2°W, while the JOSEF STEWING was still bucking 40-kt headwinds, 500 mi to the west. For the next 24 hr, the central pressure changed very little as the LOW continued northeastward. The C. P. EXPLORER was battered by 45-kt winds as the center passed very near her position. The C. P. VOYAGEUR and the CRANIA, both encoded 40-kt gales with high seas. Ocean Station Vessel "J" was disturbed by 35- to 40-kt winds during the LOW's passage. On the 27th, the LOW took its last swipe at the major shipping lanes, and it was the most powerful. The AMERICAN LEADER had the worst of it at 54.5°N, 21.6°W, with 60-kt winds and 39-ft seas. The C. P. VOYAGEUR and the ATLANTIC CAUSEWAY were both rocked by winds of 55 kt. The RHEIN EXPRESS, near 47.5°N, 22.0°W, reported 40-kt winds and 18-ft seas. Ocean Station Vessel "J" was bounced about by 45-kt gales and 30-ft waves. About this time, the forward movement of the LOW slowed down, turned toward the north, then northeast, and filled gradually. By the 30th, the LOW was in the vicinity of Iceland, having been robbed of its strength and absorbed by a subsequent LOW that had developed in the same area as this storm.

Casualties--There were a variety of weather-related incidents this month. The 16,157-ton ALGORAIL damaged her hull when she was blown against a pier by a strong wind, while entering the Holland Harbor Channel from Lake Michigan. The icebreaker EDISTO and the research vessel MIZAR were trapped in a 2-m. thick icepack after colliding. The collision damaged the EDISTO's steering. The 2,317-ton U. S. nuclear submarine TULLIBEE and the 5,620-ton West German freighter HAGEN collided in heavy seas and stormy weather 150 mi east of Cape Hatteras. Luckily, no injuries were reported in any of the above mishaps.

Smooth Log, North Pacific Weather

September and October 1972

SMOOTH LOG, SEPTEMBER 1972--Storms across the North Pacific were near normal for the month as far as number and intensity. The storm track, from the Sea of Japan northeastward to Bristol Bay and southwestern Alaska, was fairly heavily traversed. It was more favored than the one into the Gulf of Alaska. Central North Pacific storms took a more northerly course, crossing the Alaska Peninsula toward Bristol Bay, rather than northeasterly into the Gulf of Alaska. One storm, near the latter part of the month, managed to penetrate the Pacific High and approach the west coast of the United States.

The Aleutian Low, 1007-mb, whose climatological position for September is near Cape Romanzof, Alaska, was located approximately 700 mi to the southwest of the mean position. The average central pressure was 1007 mb. The low-pressure trough which normally extends west-southwestward from the Aleutian Low was missing, resulting in a more circular configuration. A negative 5-mb anomaly was located near 38°N, 177°W, partially because of the southwesterly displacement of the Aleutian Low. The climatological Low (1007-mb) over the South China Sea was not in evidence on the mean chart as pressure for the area averaged 2 to 4 mb above normal. The Pacific High was near its normal pressure of 1024 mb, but located 300 mi to the north near 40°N, 142°W. The ridge extending westward from the mean center was not nearly so well defined. This would coincide with the southwesterly displacement of the Aleutian Low. With the northerly position of the Pacific High, a plus 6-mb anomaly was located south of the Gulf of Alaska. It is not surprising then, to find so few storm tracks in the Gulf of Alaska.

Six tropical cyclones were named in the Pacific during September, two in the eastern and four in the western Pacific. Joanne became a hurricane, and Flossie, Helen, and Ida became typhoons. Helen will long be remembered in Japan for her devastation. The eastern North Pacific tropical cyclones are described in the article appearing on page 69 of this issue.

The first week of the month was relatively quiet all across the northern Pacific until a low-pressure area of 1005 mb developed just east of the Kamchatka Peninsula near 52°N, 162°E at 1200 on the 5th. Twelve hours later, a well-developed LOW was located near the same position and the central pressure had dropped to 996 mb. A cold front extended southwestward through Uchiura Bay, then into Manchuria. The JUJU MARU reported 35-kt gales and 10-ft swells in the vicinity of the front near 49°N, 150°E. As the storm continued to deepen and move northeastward, the TOKUSHIMA MARU encountered 35-kt gales and 10-ft seas south of the center at 52°N, 165°E. On the 7th, the JAPAN LAUREL also was buffeted by 35-kt gales near 52°N, 169°E. The PHILIPPINE MAIL, at 50.9°N, 168.5°E, was not to be outdone as she encountered 45-kt gales and sea waves of 32.5 ft. By the 8th, the storm was still deepening slowly and moving east-northeastward. The MEISHUN MARU encountered the same band of gales near 50°N, 168°E. Even though the storm center moved northward and eastward, the area of strong winds appeared to remain stationary. By the 10th, the storm had moved well into the Bering Sea and the filling process with loosening gradient was under way. Several more days were required before its identity was lost as it drifted in the Bering Sea.

As the front associated with the above storm moved eastward ahead of the LOW, a wave was consolidating itself and gaining strength far to the south. By the 12th, a series of waves had rippled up the front from near 35°N, 175°E, and an elongated LOW was centered at 47°N, 157°W. The CHILE MARU was being hammered by 45-kt winds and 12-ft seas. The CARREL, PRESIDENT TYLER, and the GOLDEN BEAR were hounded by 35-kt gales and heavy seas. As the 13th came around, the PHILIPPINE PRESIDENT MAGSAYSAY, SAN FRANCISCO MARU, and SGT TRUMAN KIMBRO all were banged by 40-kt gales and moderate seas on the outskirts of the storm. On the 13th and 14th, the PRESIDENT TYLER was still being buffeted by 35- to 40-kt gales with 10-ft seas and 15-ft swells. All this time, a HIGH, centered near 48°N, 138°W, was expanding to the west and pushing the LOW southwestward. By the 15th, the front had lost its identity. The storm center finally surrendered to the HIGH except for a weak circulation.

A 1007-mb wave appeared near 33°N, 162°E on September 14, on a frontal system that extended across the Pacific from Sitka, Alaska, to Kyushu, Japan. Two old storm centers on the system were located over Nunivak Island, Alaska, and near Pusan, Korea. During the next 48 hr, the storm consolidated and moved northeastward with a central pressure of 1002 mb at 41°N, 175°E, on the 16th. The YAMAKIMI MARU encountered 40-kt gales with 10-ft seas and 15-ft swells at 39°N, 170°E. At the same time, the NEPCO COURAGEOUS had 35-kt easterly winds and 18-ft seas helping her along on her westerly course. The SILAS BENT, at 53.4°N, 176.0°E, measured 45-kt gales. Many reports of 25- to 30-kt winds were received as the LOW continued its northerly track until early on the 18th. The UNZL battled 40-kt gales while cruising in dense fog at 55°N, 179°W, when the LOW was centered at 55°N, 172°E. Twelve hours later, the OHMINESAN MARU was washed by continuous rain driven by 35-kt winds near 62°N, 178°W. At 0000 on the 19th, the OHMINESAN MARU continued to be hammered by chilling 40-kt gales with 22-ft seas and 30-ft swells. The coastal station of Anadyr, U.S.S.R., hopefully was battened down for the 50-kt easterlies that blasted the inlet. On the 20th, the storm center passed westward from the Gulf of Shelekhov and was rapidly lost by combining with a low-pressure center moving eastward out of Siberia

What appeared on the 0000 chart for the 16th as a trough alined south-southwestward from Dawson, Canada, into the Gulf of Alaska, developed into a 1005-mb LOW located 120 mi southwest of Yakutat Bay by 1200. The MOBILE reported a 35-kt gale already blowing at 56°N, 141°W, approximately 150 mi south of the center. On the 17th, there were two

reports of 35-kt winds as the MOBILE was still being pounded by the gale and the USCGC YOCONA experienced the same battering, thankful that the seas were only 3 ft and the swells about 8 ft. The storm moved southeastward down the coast and at 1200 on the 18th was located near Moresby Island. This did not prevent the VANCOUVER, which was about 500 mi away at 49°N, 141°W, from combating 35-kt gales and 12-ft seas on the 18th and 19th. As the LOW center moved onshore on the 19th near Vancouver Island, a new LOW developed in almost the exact spot as the first.

As this LOW deepened to 1001 mb and moved southeastward, the USCGC GLACIER encountered 35-kt winds but reasonable seas. On the 21st, at 0000, the BELNOR cruising near 50°N, 136°W, had 35-kt winds and rain showers. The NNCR, located just off the mouth of the Columbia River, was hit by 35-kt offshore winds and rocked by 12-ft swells as the storm deepened to 990 mb. For the next 24 hr, the LOW remained stationary and gradually filled, losing its identity late on the 23d.

On the 25th and 26th, a broad low-pressure area covered the central Pacific with several Low centers indicated, depending on the available data. By the 27th, the circulation had commenced to organize into one large LOW. A modified front lay well ahead of the pressure center. At 0000 on the 27th, the LOW was located at 43°N, 174°W, and four ships reported 35-kt winds and seas up to 15 ft with accompanying swells up to 20 ft. These included the SOLON TURMAN, FARMSUM, FORT SAINTE MARIE, and USNS FURMAN. All were well away from the low center to the east, northwest, and southwest. The MIZUKAWA MARU at 43.3°N, 162.0°W, approximately 500 mi to the east, was pounded by 40-kt winds, 15-ft seas, and 20-ft swells. Later that day, the MAC GAREGILL reported being pounded by 50-kt winds at 35.8°N, 162.0°W. The PENDRECHT was washed by 46-kt gales driving heavy, continuous rain just ahead of the cold front.

At 0000 on the 28th, the LOW had sped to 50.0°N, 168.5°W, or 500 mi, during the last 24 hr, and deepened 14 mb to 972 mb. The MAC GAREGILL could not elude the 50-kt winds, and at 0600 reported heavy intermittent rain about the time she encountered the front. The JAPAN MAIL was very near the center of the LOW, pressure was 978 mb with southerly 45-kt winds. The MIZUKAWA MARU was still being rocked by 15-ft seas and 20-ft swells, but the winds had quieted to 35 kt. The JAPAN AZALEA was proceeding in heavy drizzle driven by 35-kt winds in a slight sea. The NISSHO MARU, nearer the low's center, was regaled with 40-kt winds. By the 29th, the storm's forward surge had slowed as it passed west of Unalaska. The JAPAN AZALEA at 50°N, 165°W, was still on the receiving end of 40-kt winds and 12-ft waves, while the SLAVYANKA was faring no better on the northern side of Unalaska Island with 40-kt winds from the opposite direction.

On the 30th, the LOW started to fill and move rapidly again to the northeast, passing over Anchorage early that day. The effects were still being felt on the western fringe as 35-kt winds with snow showers were visiting isolated land stations on the Chukchi Sea and in the Bering Strait. The LOW proceeded into northern Alaska, where it idled until October 3d and was absorbed by another following in its foottracks.

Flossie was spotted as a depression in Lamon Bay on the 10th. She made her way westward across the adjacent island of Luzon and into the South China Sea the next day. Once over these friendly waters, Flossie reached tropical storm strength on the 12th near 15°N, 115°E. About this time, some 200 mi east-northeast of Flossie's birthplace, another depression came to life. This storm, which was to be short lived, became tropical storm Grace on the 13th. At this time, the tropical storm twins were centered on the 15th parallel, some 600 mi apart. While Grace meandered off the Philippine coast, the small but potent Flossie hugged the 15th parallel on her way toward South Vietnam. On the 14th, Flossie reached typhoon strength about the same time Grace was being gobbled up by another typhoon--Helen. Before hitting the South Vietnam coast on the 15th, Flossie generated winds up to 80 kt with 120-kt gusts near her center. Flossie dropped to tropical storm strength after moving inland south of Da Nang. She weakened slowly and was absorbed by a large trough covering southeast Asia on the 17th. But whatever happened to typhoon Helen?

Well, Helen was not your average typhoon. She was a blockbuster on land and sea. In Japan, her devastating winds and torrential rains were responsible for at least 40 deaths, plus widespread destruction. At sea, several fishing boats were sunk, and, in Ise Bay, nine cargo ships ran aground, including the 6,244-ton Indian cargo ship STATE OF TRAVAN COCHIN.

Helen started quickly when she reached typhoon strength on her very first day. She was first detected as a tropical depression near 15°N, 136°E, on the 13th. After traveling north-northwestward until the 15th, the typhoon turned north-northeastward toward Honshu. Winds were up to 90 kt with 130-kt gusts near the center, which was at 23°N, 131°E. A report from the OJIKA, some 180 mi west of the storm's center on the 16th at 0000, indicated she was battling 20-ft seas and 40-kt winds. A few hours later, Helen moved inland over Honshu, just east of the already battered Shikoku.

A frontal passage on the 15th drenched Shikoku with 10 to 14 in. of rain; Kochi City recorded 3.62 in. in a 1-hr period. Resultant landslides killed 13 persons and flattened many homes.

Helen's eye crossed the Honshu shore near Cape Shio. By Saturday evening the 16th, 8 to 15 in. of rain had fallen over central Honshu; Owase had recorded more than 24 in. Winds were up to 105 kt in Aichi Prefecture and 5-ft above-normal tides battered exposed coastal areas. At Nagoya, the tide was 3 ft above normal. During the night, two tuna boats sank off Hachijo Island, south of Tokyo. A total of 24 crewmen drowned as 35-ft seas hampered rescue operations. Helen stalled in the Sea of Japan on Sunday. Here she was able to generate storm tides along the east coast of the Korean Peninsula on the 19th. Along with 4-in. rains, the tides were responsible for heavy damage and at least two deaths. At 1200 on the 19th, a ship (GNOU) battled 40-ft seas in 45-kt winds on the west side of Helen. As Helen drifted northward, she generated torrential rains of up to 31 in. over Hokkaido. Flash floods and landslides brought this northern Japanese island to a standstill. In Hokkaido, eight people were killed and two were

missing. As happened off Korea, scores of fishing boats were caught with their nets down. The Japanese boats in the northern Sea of Japan sought refuge off Sakhalin. On the 20th, the storm petered out as it crossed Hokkaido. The 1,998-ton HAKOZAKI and the 3,606-ton MARAKATA both ran aground during typhoon Helen on the 16th.

While Helen was taking her final bows over Hokkaido, typhoon Ida was preparing for her debut in the Japanese theater. Fortunately, she elected, at the last minute, to bypass Japan and did what amounted to a brief one-night stand. Ida did, however, take her show to the island of Chichijima, about 750 mi south of Tokyo, on the 23d. She played to an empty island as she passed within 80 mi. At the time, Ida's central pressure was 935 mb. Maximum winds were 110 kt with gusts to 150 kt. Press reports afterward indicated the performance on Chichijima was devastating.

Ida was found on the 17th near 17°N, 155°E. At that time, she was a mere depression. By the 19th, she reached typhoon strength and was heading toward the west-northwest and the big time. On the 21st, Ida, packing 95-kt winds, took her road show to the northern Mariana Islands. About this time, she began to recurve. On the 23d, the typhoon barreled through the Volcano Islands on a north-northeasterly heading. The PRESIDENT ADAMS caught the 0000 show on the 24th, some 200 mi north-northeast of Ida's center, and reported 50-kt winds from the east-southeast. Twelve hours later, the ASHBY MARU, caught between Ida and Honshu, witnessed 40-kt winds in 16-ft seas. On the 25th, early in the day, the LORD OF THE ISLE, about 300 mi to the southeast, was bucking 52-kt storm gales. Ida turned extratropical late on the 25th, and the following day weakened drastically. This did not prevent the GOPHER STATE from having to contend with 55-kt westerly winds at 36.5°N, 159.8°W, about 300 mi south of the center. She also was riding 39-ft waves.

Casualties--There were many casualties in the vicinity of Japan that were associated with typhoon Helen. The only other casualty involving weather was the collision of the American C. E. DANT (12,724 tons) and the Liberian motor vessel AEGEAN SEA. They collided in heavy fog in the Strait of Juan de Fuca. (fig. 27). Happily, no one was injured.

Figure 27.--The C. E. DANT and the AGEAN SEA locked together--The vessels collided in poor visibility in the Strait of Juan de Fuca on September 4. Wide World Photo.

SMOOTH LOG, OCTOBER 1972--Cyclone activity over the North Pacific during October was near normal, both in number and area traversed. Except for isolated circumstances, all major extratropical cyclone tracks were north of 35°N. The primary tracks were out of Siberia, across the Sea of Okhotsk, and into the Bering Strait; and from east of Japan, up the Aleutian Island chain, and into the Gulf of Alaska. A secondary track was from northeast of Midway Island, north-northeastward into the Gulf of Alaska.

The Aleutian Low, normally centered over the Alaska Peninsula, northwest of Kodiak Island, was near 60°N, 170°W, in the Bering Sea. The mean central pressure of 1005 mb was 5 mb higher than normal. The eastern center of the Pacific High was 2 mb higher than the normal mean of 1022 mb and 11° to the north (40°N, 140°W) of the mean position. The western Pacific center of the elongated climatological High was located near its usual mean position of 30°N, 175°E but was 3 mb higher than its normal 1019-mb value. The trough separating the two was deeper and sharper. This, at least partially, explains the lack of cyclonic activity south of 25°N. The largest anomaly was a positive 9 mb, north of the position of the eastern Pacific High, just south of the Gulf of Alaska. A plus 3-mb anomaly was centered near 26°N, 120°W, off Baja California, and a plus 3-mb anomaly ridge along 170°E from 30°N to 60°N. The sharp trough was reflected by a negative 2-mb anomaly near 35°N, 160°W.

Five named tropical storms occurred in western Pacific waters during the month. Four (Lorna, Marie, Nancy, and Olga) reached typhoon intensity; Kathy qualified for tropical storm status. In the eastern Pacific, only tropical storm Kathleen disturbed the peaceful waters. Kathleen is described in the article "Eastern North Pacific Tropical Cyclones, 1972" appearing on page 69 of this issue.

The first storm of significance was conceived during late September but did not mature until October. The LOW formed in a trough in association with a weak front. The storm moved steadily eastward, and, at 1200 on the 1st, the LOW was located near 49°N, 154°W, with a central pressure of 984 mb. During that day, the OKADA MARU and the WASHINGTON were regaled with 40-kt winds. The WORLD CREST, at 39°N, 171°W, was heading into 45-kt gales and 20-ft swells. By 0000 on the 2d, the LOW had raced to 54°N, 147°W, a distance of about 900 mi for a speed of 35 kt. The central pressure had dropped to 961 mb. The extremely tight gradient produced 40- to 50-kt winds which pounded the JAPAN, JAPAN-WALNUT, KUNGER, NIIHAMA MARU, PHILIPPINE MAIL, SUMMIT, and the WASHINGTON. A ship which could not be identified was hammered by 60-kt winds. The swells were generally 15 to 20 ft, but the SUMMIT encountered swells of 30 ft. On the 3d, the LOW passed into Alaska near Valdez and began to fill and weaken. At 0000 on the 3d, the AMSTELLAAN and the ZENIKOREN MARU reported 45- and 40-kt gales, respectively. Once over land, the LOW filled as rapidly as it deepened. The last identifiable remains was a 1014-mb trough at 0000 on the 4th, still near Valdez.

A LOW formed over the northern Kamchatka Peninsula on the 10th, and moved southeastward. Between the 10th and 13th, the LOW traveled to near 52°N, 173°W and the following vessels reported 35- and 40-kt gales: the HOYO MARU, JAPAN MAPLE, MARUSUMI MARU, and the ZENKOREN MARU. At 0000 on the 12th, the GEORGIANA, at 49.7°N, 174.3°E, was battling 56-kt winds accompanied by 46-ft seas.

On the 13th, a 1002-mb LOW developed on the front, south of the original LOW, near 40°N, 168°W. Twenty-four hours later, its pressure was 990 mb and was causing havoc over a wide area. The IDAHO, PRESIDENT LAUREL, and the PRESIDENT MCKINLEY were south and east of the LOW and bucking 35-kt winds. The DERWENTFIELD was regaled by 40-kt and the KLAUS LEONHARDT was hammered by 45-kt winds and the PRESIDENT GARFIELD had rain, driven by 55-kt winds, near the front.

The LOW moved north and deepened to 966 mb and was at 50°N, 166°W on the 15th. The KASHU, MARNE LLOYD, TACOMA CITY, TOYOTA MARU, and the TRANSOCEAN TRANS were hit by 35- to 40-kt winds to the south and west of the center. At the same time, the GAIST, JAPAN WALNUT, KURE MARU, and the WASHINGTON MAIL were being blown by southerly 35- to 40-kt gales along the front.

Late on the 16th, the LOW crossed northward into Bristol Bay and the colder waters started to take their toll. In the meantime, the ACILA, MITO MARU, NELSON MARU, and the WASHINGTON MAIL were hounded by winds up to 40 kt. On the 17th, the LOW approached the Bering Strait with the AMERICAN MAIL reporting 40-kt winds and 26-ft swells near 57°N, 177°W. With the 4°C temperature, the chill factor made me glad to be in a warm office. On the 19th, all traces of the LOW had vanished.

The Sea of Japan hosted a 1006-mb LOW, at 1200 on the 15th. It moved northeastward along the Kuril Islands, slowly deepening. At 1200 on the 17th, it was over Ostrov Shumshu and the ROBERT BANK, 300 mi to the south, was the lucky recipient of 50-kt winds. On the 18th, the TRANSOCEAN TRANSPORT, to the south, and the WASHINGTON MAIL, to the east, were buffeted by 45-kt gales. It was at this time, that the central pressure was at its lowest, 981 mb. The LOW continued northeastward and crossed into the Bering Sea on the 19th. On the 20th and 21st, it dawdled near Bristol Bay and was last noted late on the 22d over Norton Sound.

On the 1200 chart of the 20th, a new LOW was analyzed with the help of many fine ship reports. This appeared to be almost an explosive development, as ship reports in the same and surrounding area 12 hr earlier indicated only a slight troughing upstream. The LOW center of 1004 mb was located near 43°N, 163°E where, 12 hr earlier, a straight flow (1016 mb) isobar appeared. The NIPPON MARU, 200 mi south of the center, was caught by 40-kt gales. The WOKO MARU was encountering 35-kt winds approximately 400 mi southwest of the LOW. Twelve hours later, at 0000 on the 21st, the NIPPON MARU was still being buffeted by 35-kt gales and the ACILA had joined her ranks. By 0000 on the 22d, the LOW had moved westward to 43°N, 175°W, with a central pressure of 990 mb. The winds had picked up considerably, with the BUENOS AIRES MARU being pounded by 50-kt gales and 15-ft swells; the TOYOTA MARU, at 36°N, 172°W, had heavy drizzle driven by 45-kt gales. The AKAGISAN MARU and the SILVER ARROW reported 35- and 40-kt winds. The former was exactly on the frontal position with heavy rain and a southerly wind. Twelve hours later, the ILLINOIS was pounded by 50-kt gales, as the LOW curved northeastward. On the 23d, the system developed dual LOWS, which weakened the gradient and lessened the winds. Only Ocean Station Vessel "P" reported 35-kt winds at this time. The LOW was located in the Gulf of Alaska on the 24th and had filled to 994 mb. The OTRADNOE was buffeted by 45-kt gales, south of Chirikof Island. A small HIGH over central Alaska and St. Elias Mountains, along the coast, absorbed the LOW, leaving only a trough on the 25th.

On the 26th, a 1004-mb LOW was slowly moving eastward out of Manchuria, where it was depositing moderate snow. It caused little concern to larger ships until the 28th, when its central pressure was 972 mb, and was located at 52.5°N, 152.0°E. South of the center, the HONSHU MARU had 35-kt gales while the MEISHUN MARU, OREGON MAIL, and the PACIFIC LOGGER were honored with 40-kt. As the LOW passed over the Kamchatka Peninsula, the HOLLANDS BRINK and the SETYU MARU were lashed by 40- to 45-kt westerlies. The LOW continued on an easterly track and on the 29th was at 56°N, 180°. The EASTERN BUILDER and the SAN FRANCISCO experienced 40- and 45-kt gales. About this time, things started falling apart as the LOW that once was typhoon Olga approached from the southwest. The LOW continued on a northeasterly course, gradually weakening, and by the 5th, it was just offshore from Ketchikan, Alaska, and scheduled to be absorbed by another low-pressure system, fast approaching from the west.

Tropical storm Kathy and typhoon Lorna formed on the 1st day of the month. Kathy developed east of the Mariana Islands. Lorna developed in the South China Sea. Before the day was through, Lorna was a typhoon, with 70-kt maximum winds, bound for Hainan

and Vietnam. Kathy's maximum winds were 60 kt. Both were on a west-northwesterly course. On the 2d, Lorna brushed southern Hainan, moved across the southern Gulf of Tonkin and into North Vietnam. Winds remained at minimal typhoon force until Lorna was ashore. Meanwhile, Kathy jogged across the 20th parallel and headed westward. On the 3d, as Lorna was dying over land, Kathy maintained her 55- to 60-kt winds and plodded westward. The following day, Kathy recurved, first toward the northwest and then, on the 5th, toward the north.

Tropical storm Kathy on a northerly course had incorporated a cold front into her circulation and became extratropical near 30°N, 137°E at 0000 on the 6th. The central pressure had risen to 1007 mb, but this was only a breather as the storm immediately started deepening with the cold air infusion and was reported down to 990 mb by 1200 that day. The JAPAN AZALEA became painfully aware of this as she encountered 45-kt gales, north of the LOW center near 38°N, 144°E at 1200. Many miles to the north, the KASHIMA MARU reported 40-kt winds along the same front, which was crowded into a tight gradient, on the back side of a large HIGH. On the 7th, the KLAUS LEONHARDT and the SAGAMI MARU were struck by 35- and 40-kt winds on opposite sides of the northeastward moving LOW. At 1200 on the 8th, the LOW was located at 44°N, 172°E and the GEORGIANA, KINKO MARU, and the VYSSOTSK were regaled by 35-kt winds and the DAIAN MARU, by 40-kt winds. The LOW was rapidly being crushed between the two high-pressure areas, and the gradient along the front remained tight due to this squeezing. The GEORGIANA (moving west toward the front and the northeasterly moving LOW) reported 40- and 45-kt gales with swells to 25 ft on the 9th. By 0000 on the 10th, the squeeze play had succeeded and the LOW no longer existed.

On the 5th, a tropical depression was sighted about 300 mi south of Wake Island. This was the start of something big--typhoon Marie. The depression became a tropical storm, and the tropical storm became a typhoon on the 6th. The typhoon moved west-northwestward at about 20 kt. Maximum winds, close to her core, climbed slowly--95 kt on the 7th, 100 kt on the 8th, 115 kt on the 9th. By the 9th, the storm had reached her peak. Marie, as dawn was breaking, moved into the northern Marianas. Winds of 100 kt or more extended 50 mi in all directions while gale-force winds extended out to 375 mi. Gusts near the center were estimated at 155 kt. On the 10th, Marie began to recurve and her winds began to drop. By the 11th, she crossed the 25th parallel near 144°E. Maximum winds were 90 kt near her center. Marie's center stayed more than 300 mi east of the Honshu coast as she traveled northward on the 12th. Her effect, however, was felt in Japanese coastal waters. The 77-ton fishing vessel No. 81 YAHATA MARU capsized in these storm-whipped waters. While all the 18 crew members escaped in a rubber raft, all but two were lost prior to rescue. Marie turned extratropical on the 12th, as she crossed the 35th parallel near 148°E.

Nancy, the strongest typhoon of the month, was confined to a life at sea. She was detected in a tropical storm state about 250 mi southeast of Wake Island on the 16th. The following day, Nancy reached typhoon strength as she traveled on a westerly course. Nancy peaked on the 18th while recurving. Maximum winds reached 120 kt with gusts to 160 kt near 18°N, 160°E. During the next few days, the typhoon continued on a parabolic track that took her between Marcus and Wake Islands. Her intensity declined with increasing latitude. On the 19th, she crossed the 20th parallel at 120 kt, and the next day crossed the 25th parallel near 160°E, at 80 kt. Nancy began to turn extratropical, late on the 21st.

Olga developed deep in the Tropics. She was estimated to be at typhoon strength east of the Marshall Islands on the 22d. The typhoon moved west-northwestward through the Marshalls on the 23d and 24th. The storm passed 150 mi to the northwest of Kwajalein, where a maximum sustained wind of 23 kt, from the north-northwest, was recorded on the 23d. Also observed was a peak gust from the north at 33 kt. When Olga left the Marshalls, her maximum winds had dropped to 50 kt. Moving west-northwestward at about 15 kt, Olga reorganized on the 25th. By the 26th, she was again a typhoon near 14°N, 157°E. She continued to strengthen. The following day, Olga was a classic typhoon. Maximum winds reached 115 kt with gusts estimated to 150 kt. It was at this intensity that she banged through the northern Mariana Islands. Typhoon Olga began to recurve as she crossed the 20th parallel near 144°E. Winds began to diminish somewhat, and cold air began to turn Olga extratropical. Her movement was toward the north at a forward speed of 25 kt.

At 1200 on the 29th, typhoon Olga was declared extratropical at 34°N, 147°E with a central pressure of 980 mb. Most shipping had given Olga a wide berth, but on the 30th the RICHMOND MARU and the TAIKAI MARU were bounced by 40- and 45-kt winds with seas and swells up to 25 ft. At 1200 on the 30th, the central pressure was down to 966 mb near 46°N, 163°E and the TOYOTA MARU #8 was being pounded by 45-kt winds from all directions, as she passed very near the center of the LOW. Farther south by 500 mi, the MONTREAL MARU had an easier go with 40-kt gales, but the waves were running 25 ft. At 0000 on the 31st, the central pressure had fallen to 960 mb and the GZRY, and the TETSUZUI MARU were caught in 45- to 50-kt winds. The DAISHOWA MARU, which was closer to the LOW's center, was pounded by 60-kt winds, blowing in the same direction as she was headed.

By this time, it appears the word had gotten around and most ships were avoiding the storm, when possible. On November 1, the LOW was moving eastward along 45°N and weakening. The HAI KING and the KOWA MARU were both buffeted by 40-kt gales, south of the center. The LOW continued its easterly course and, at 1200 on the 2d, was near 48°N, 144°W. During this time, the EVER LIGHT encountered 35-kt gales, and the AMERICAN ROBIN and the HARIMA MARU, which were closer to the center, were treated to 40-kt gales.

Casualties--There were three weather-related mishaps that came to our attention this month, one of which was described under typhoon Marie. All were smaller type ships. The 104-ft MORNING STAR was sliced in half by an unknown merchant ship in heavy fog and high seas off Cape Mendocino, Calif., on the 5th; two lives were lost. The 492-ton SANYO MARU sank in Tsugaru Channel on the 17th.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

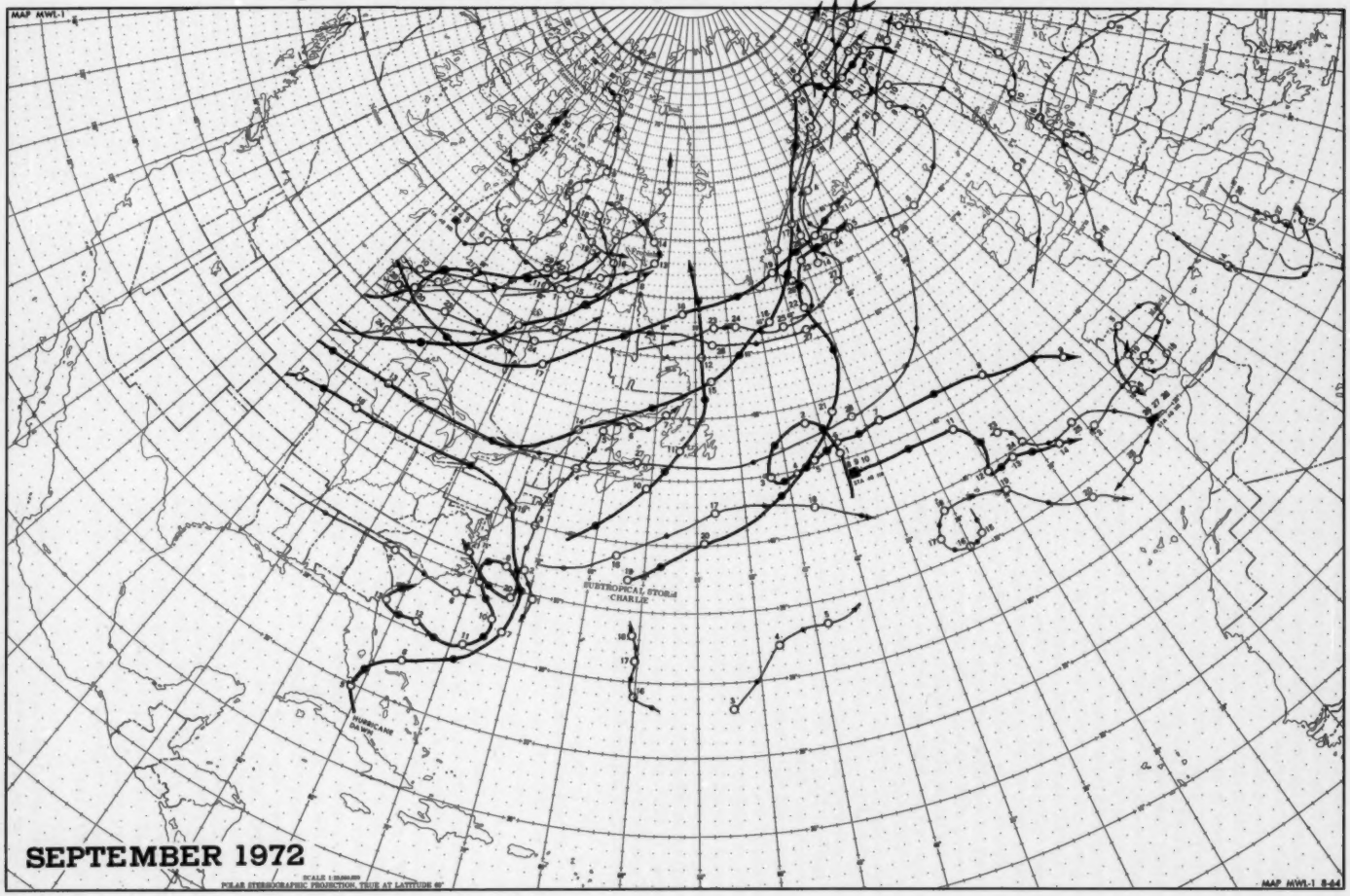

Figure 28. -- Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

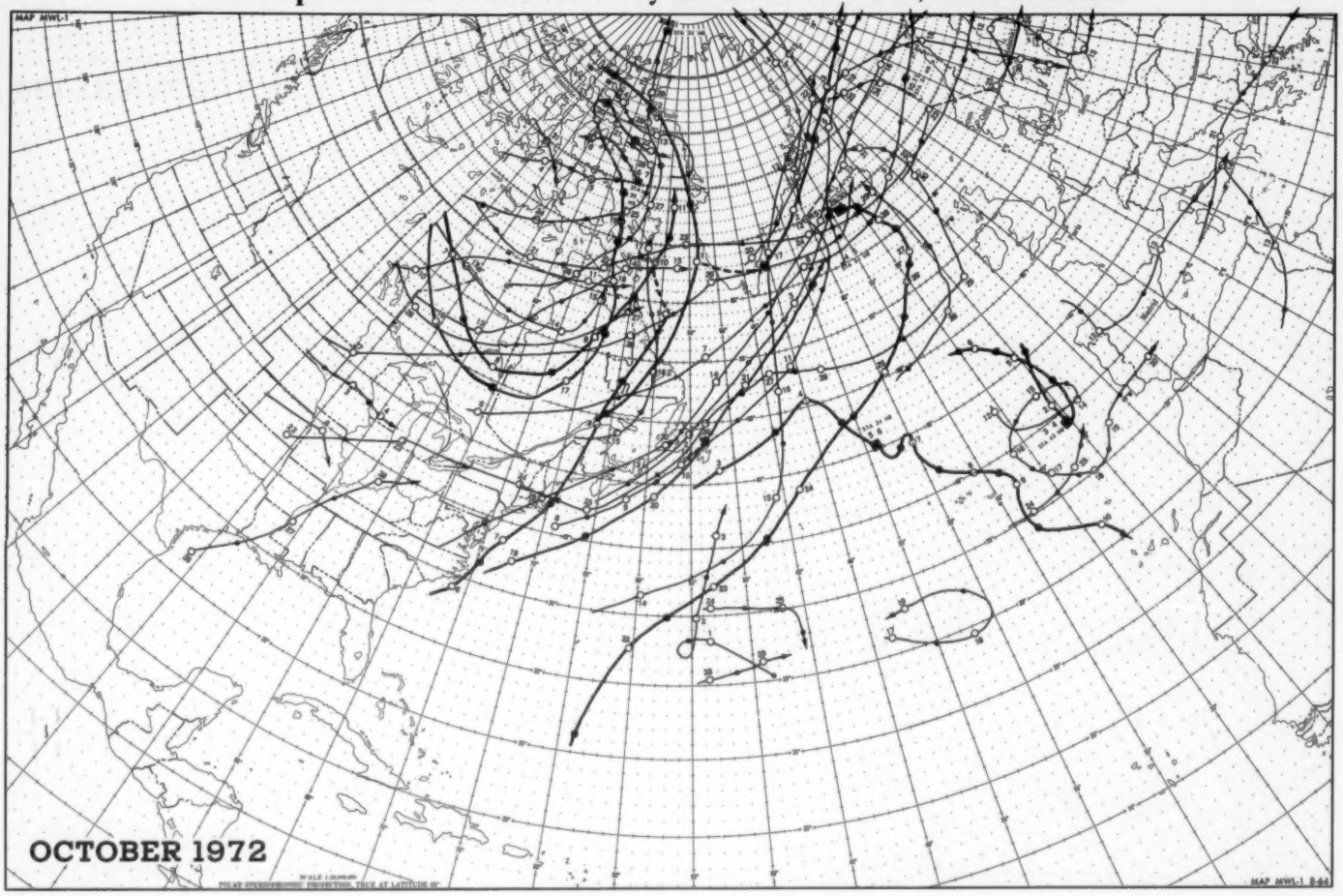

Figure 29. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

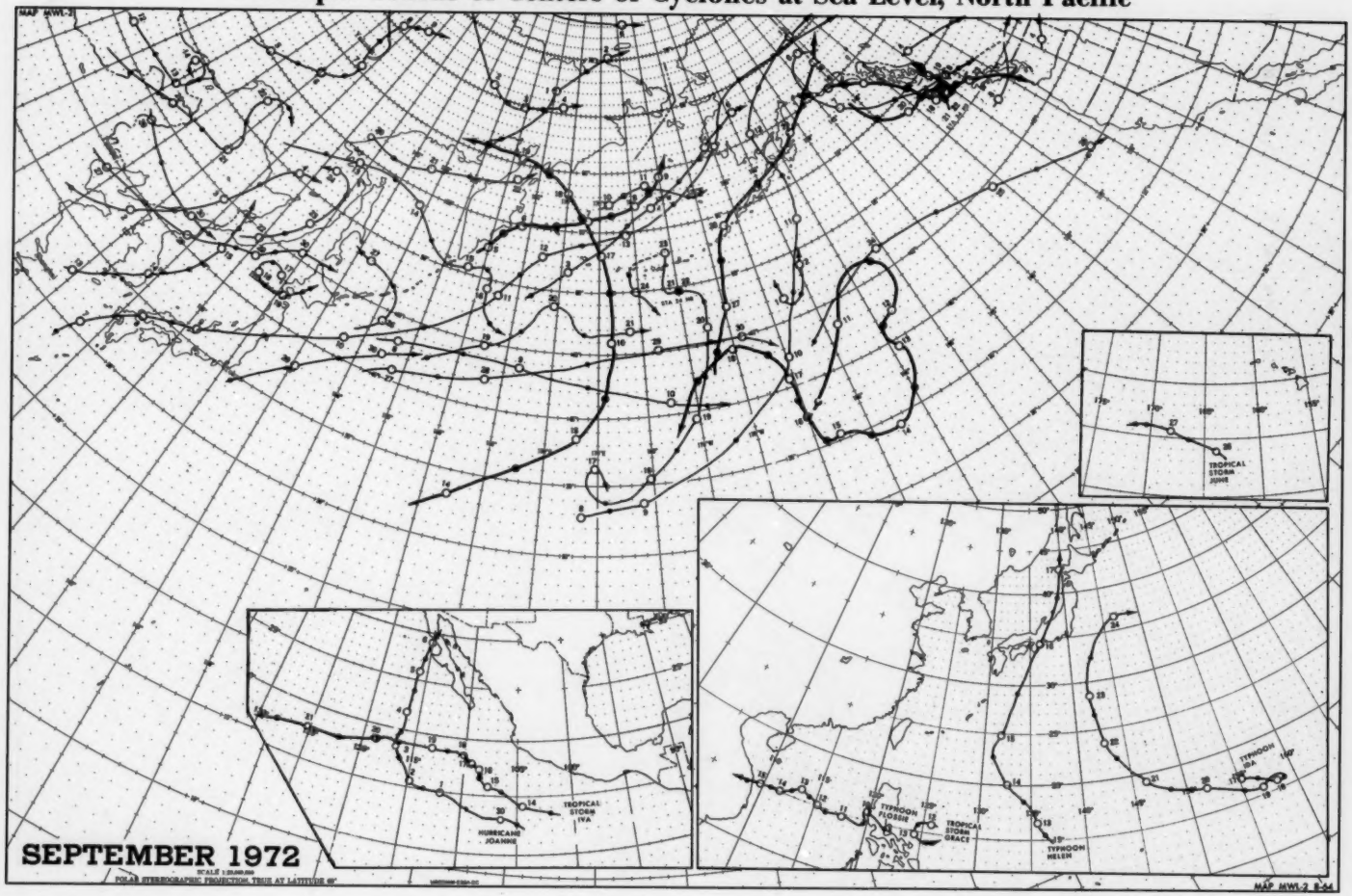

Figure 30. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

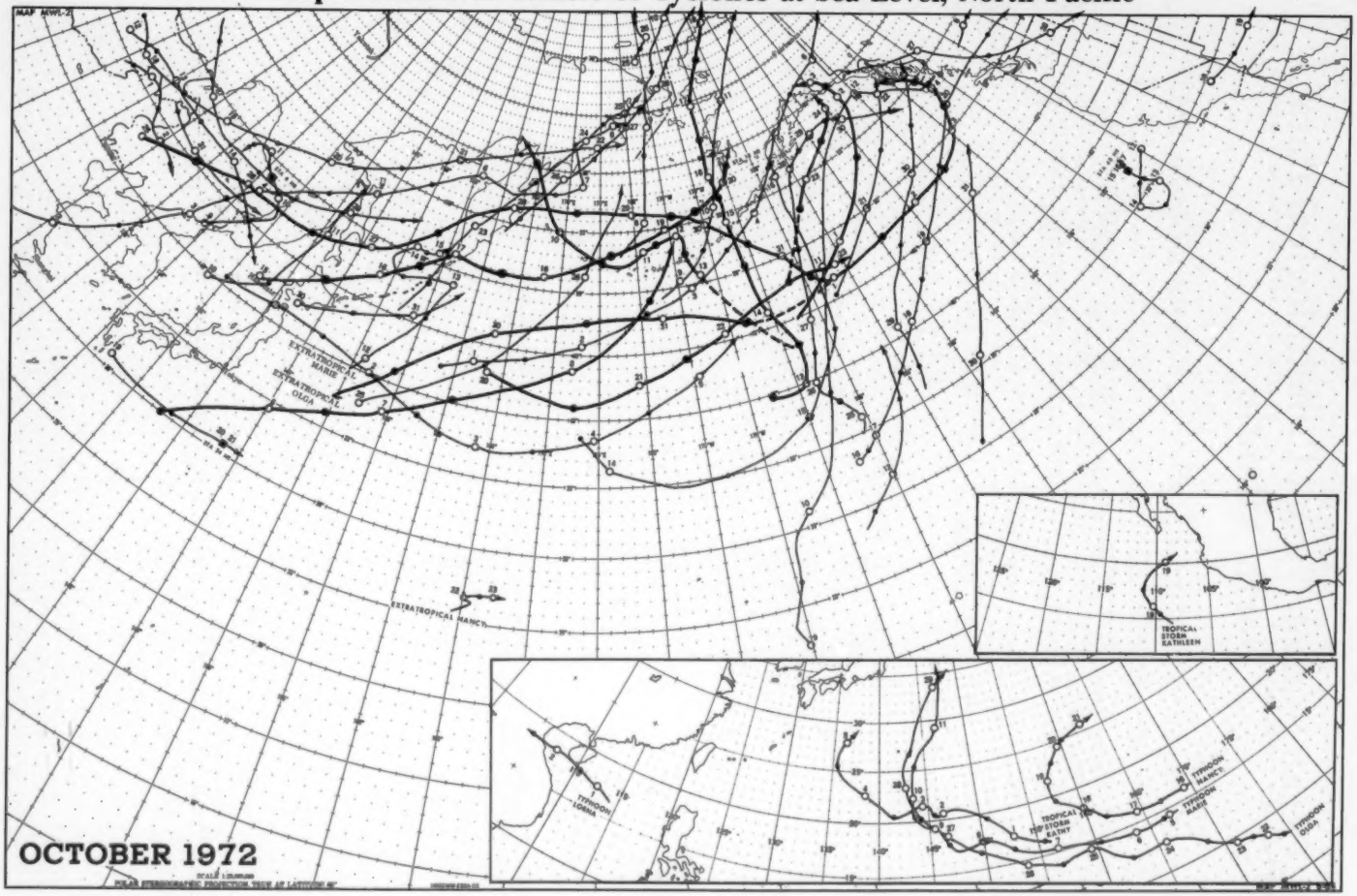

Figure 31.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Table 6
U.S. Ocean Station Vessel Climatological Data
North Atlantic

Ocean Weather Station 'BRAVO' 56°30'N 51°00'W **September and October, 1972**

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
SEPT	2.0	29 00	6.1	9.8	17 18	- 4.4	•29 03	3.5	8.0	12 18	5.0	•23 03	8.8	8.0	•07 18	- 3.7	21 06	- .6	2.0	17 18
OCT	- 2.1	31 18	3.2	9.6	01 12	- 8.6	30 21	- .8	6.3	01 15	3.9	12 09	4.9	6.4	03 00	- 6.2	31 18	- 1.7	3.8	01 12

MONTH	MEANS AND EXTREMES PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS) TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER RAIN OR PCPN	DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	SOBS WITH PCPN	NO OF OBS
SEPT	977.5	24 03	1009.6	1030.8	04 15	2.9	13.8	32.9	50.4	11.3	21.7	30.4	36.7	22	21	4	0	7	12	3	1	30	18.3	240
OCT	989.2	09 18	1012.4	1030.6	21 00	3.9	15.5	31.3	48.4	17.2	22.8	31.5	28.4	24	23	14	0	4	11	0	0	26	27.5	233

** VV-90-93 AND/OR 9-4 COMP OB DAYS-COMPLETE OB DAYS

Wind

SEPT WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.7	.3	.9	2.0	.7	.0	4.7	22.9
NE	.1	.1	9.3	.5	.0	.0	9.0	19.7
E	.0	1.9	9.4	.7	.0	.0	6.0	13.4
SE	.0	3.8	7.0	1.9	.1	.4	12.7	19.2
S	.0	2.0	10.7	3.9	.9	.0	23.1	16.9
SW	.1	1.0	3.8	3.5	.1	.0	8.4	18.8
W	.7	.7	7.3	3.4	1.9	1.0	17.8	23.1
NW	.4	.8	5.9	12.4	1.5	.1	21.1	24.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	2.1	11.3	50.4	29.4	6.5	2.1	100.0	19.8

NUMBER OF OBS 240 | MAX WIND DIR 280 | SPEED 65 | DA HR 19 0100 | VECTOR SPEED 6.2 | MEAN DIR 263 (DIR IN DEGREES)

OCT WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	1.5	1.7	1.6	.0	.0	4.8	18.9
NE	.0	1.4	1.7	1.7	.0	.0	4.8	17.3
E	.0	1.8	3.0	1.2	.0	.0	5.8	13.7
SE	.0	.4	1.7	3.2	1.4	.0	6.8	24.8
S	.0	.0	2.5	7.7	2.1	.0	12.3	27.0
SW	.0	.0	7.4	9.4	2.0	.0	19.5	23.8
W	.0	2.6	10.5	5.5	.3	.0	18.9	19.7
NW	.0	1.3	10.5	11.7	1.4	.0	24.9	22.1
CALM	2.1	.0	.0	.0	.0	.0	2.1	.0
TOTAL	2.1	9.4	39.1	42.1	7.3	.0	100.0	21.3

NUMBER OF OBS 233 | MAX WIND DIR 120 | SPEED 47 | DA HR 09 0000 | VECTOR SPEED 8.4 | MEAN DIR 293 (DIR IN DEGREES)

Wave

SEPT WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	1.4	3.3	2.1	.6	.0	.0	.0	7.6
NE	.0	1.3	2.9	.0	.0	.0	.0	.0	4.2
E	.0	1.6	1.6	.0	.4	.0	.0	.0	3.5
SE	.0	9.6	13.0	1.0	.0	.0	.0	.0	24.3
S	.0	2.1	4.4	1.5	.0	.0	.0	.0	7.9
SW	.0	1.4	.1	.4	.1	.0	.0	.0	2.0
W	.0	3.7	4.7	1.6	4.4	2.3	.0	.0	16.7
NW	.0	3.8	6.6	4.7	7.0	1.0	.0	.0	29.1
IND	.0	3.6	2.1	.8	.0	.0	.0	.0	6.5
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	34.6	37.5	12.1	12.5	3.3	.0	.0	100.0

NUMBER OF OBS 240 IND=INDETERMINATE

OCT WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	.9	1.7	.4	.0	.0	.0	.0	2.5
NE	.0	.9	1.1	.4	.1	.0	.0	.0	2.5
E	.0	3.0	3.9	1.6	.9	.0	.0	.0	9.4
SE	.0	.4	1.3	1.0	.9	1.0	.0	.0	4.7
S	.0	2.0	1.8	1.9	6.1	.3	.0	.0	12.0
SW	.0	1.5	5.7	3.6	5.5	.4	.0	.0	16.7
W	.0	6.1	9.1	2.0	2.9	.2	.0	.0	20.2
NW	.0	3.3	9.3	7.0	6.1	.0	.0	.0	25.8
IND	.0	2.1	1.7	2.1	.9	.0	.0	.0	6.9
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	19.7	35.6	20.2	22.7	1.7	.0	.0	100.0

NUMBER OF OBS 233 IND=INDETERMINATE

SEPT WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	7.5	.4	.8	.0	.0	.0	.0	8.8
6-7	.0	17.1	20.0	9.2	3.3	.0	.0	.0	49.6
8-9	.0	4.2	13.3	1.3	6.8	3.3	.0	.0	30.5
10-11	.0	.0	1.7	.0	.4	.0	.0	.0	2.1
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	5.8	2.1	.8	.0	.0	.0	.0	8.8
TOTAL	.0	34.6	37.5	12.1	12.5	3.3	.0	.0	100.0

NUMBER OF OBS 240 | MAX WAVE HEIGHT NOT 7.9 | PER 8 | DIR 280 | TYPE SEA | DA HR 19 09 (DIR IN DEGREES) IND=INDETERMINATE

•ALSO OCCURRED ON PREVIOUS OBSERVATIONS

OCT WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	5.2	6.4	.4	.0	.0	.0	.0	12.0
6-7	.0	10.3	18.3	7.3	.9	.0	.0	.0	34.8
8-9	.0	1.7	10.7	9.4	18.3	1.7	.0	.0	42.1
10-11	.0	.4	.4	.9	2.6	.0	.0	.0	4.3
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	2.1	1.7	2.1	.9	.0	.0	.0	6.9
TOTAL	.0	19.7	35.0	20.2	22.7	1.7	.0	.0	100.0

NUMBER OF OBS 233 | MAX WAVE HEIGHT NOT 6.0 | PER 8 | DIR 210 | TYPE SEA | DA HR 01 15 (DIR IN DEGREES) IND=INDETERMINATE

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 7
CLIMATOLOGICAL DATA

Ocean Weather Station 'CHARLIE' 52°45'N 35°30'W — September and October, 1972

MEANS AND EXTREMES

	DRY BULB TEMP (°C)					DEW-POINT TEMP (°C)					SEA TEMP (°C)					AIR-SEA TEMP DIFFERENCE (°C)				
MONTH	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR
SEPT	6.0	29 18	11.3	19.1	05 12	2.0	*28 18	8.7	14.4	16 03	8.3	29 03	11.3	13.3	11 18	- 0.8	29 18	- .3	4.0	12 09
OCT	4.7	26 12	9.6	12.8	*14 15	- 2.5	27 00	6.9	12.4	11 12	8.9	27 03	10.2	12.4	*24 21	- 0.6	28 15	- .6	3.1	11 12

MEANS AND EXTREMES — PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS) — DAYS WITH SPECIFIED WEATHER

	PRESSURE (MB)					TOTAL CLOUD				LOW CLOUD				RAIN OR			VERY	WIND (KTS)				
MONTH	MIN	DA HR	MEAN	MAX	DA HR	0-2	3-5	6-7	8 & OBSC	0-2	3-5	6-7	8 & OBSC	PCPN	DRZL	SNOW	TSTM	<1KM **	≥34	≥48	≥64	COMP OB DAYS	SLOBS WITH PCPN	NO OF OBS
SEPT	985.3	21 21	1013.7	1029.5	04 09	7.1	17.5	32.2	43.1	28.1	21.8	24.6	27.5	21	20	1	0	10	10	1	1	23	17.5	211
OCT	1001.2	05 00	1017.8	1035.2	20 21	6.1	7.8	23.9	62.2	14.4	16.7	26.1	42.8	13	13	0	0	10	5	0	0	21	10.6	140

** VV-90-93 AND/OR H=4 COMP OB DAYS-COMPLETE OB DAYS

Wind

SEPT — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

	WIND SPEED (KNOTS)							
DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	.9	1.2	.0	.0	.0	2.1	10.9
NE	.0	1.4	1.9	3.1	1.8	.0	8.2	24.3
E	.0	.5	0.8	2.7	1.1	.0	11.0	21.2
SE	.0	5.8	7.9	3.0	.0	.0	16.7	19.6
S	.0	3.7	3.3	6.6	.9	.0	14.6	20.2
SW	.0	3.9	5.8	4.6	1.4	1.4	16.8	23.0
W	.0	1.2	4.6	19.5	.0	.0	25.4	24.1
NW	.0	.1	2.5	2.1	.0	.0	4.7	21.4
CALM	.5	.0	.0	.0	.0	.0	.5	.0
TOTAL	.5	17.5	33.6	41.7	5.2	1.4	100.0	21.2

NUMBER OF OBS	MAX WIND DIR	MAX WIND SPEED	MAX WIND DA HR	VECTOR SPEED	MEAN DIR	(DIR IN DEGREES)
211	240	70	22 0045	6.3	213	

OCT — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

	WIND SPEED (KNOTS)							
DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	1.7	8.2	2.9	2.6	.0	15.4	21.4
NE	.0	2.9	6.0	.8	.1	.0	9.9	19.9
E	.0	.0	.8	.4	.0	.0	1.3	16.3
SE	.0	.6	2.5	1.3	.0	.0	4.3	16.4
S	.0	.6	8.8	5.4	.0	.0	14.7	19.8
SW	.0	2.9	13.8	5.7	.0	.0	22.4	17.3
W	.0	1.3	8.1	4.3	.0	.0	13.9	17.6
NW	.0	1.3	7.3	6.4	1.7	.0	17.1	22.5
CALM	1.1	.0	.0	.0	.0	.0	1.1	.0
TOTAL	1.1	11.7	55.6	27.2	4.4	.0	100.0	18.8

NUMBER OF OBS	MAX WIND DIR	MAX WIND SPEED	MAX WIND DA HR	VECTOR SPEED	MEAN DIR	(DIR IN DEGREES)
180	350	43	05 0600	6.6	277	

Wave

SEPT — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

	WAVE HEIGHT (METERS)								
DIR	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	2.1	.5	.0	.0	.0	.0	.0	2.6
NE	.0	2.7	1.5	2.8	2.0	.0	.0	.0	9.1
E	.5	2.4	3.2	1.4	.8	.0	.0	.0	8.3
SE	1.4	8.2	1.9	3.2	.0	.0	.0	.0	14.7
S	1.3	5.1	2.7	4.4	1.3	.0	.0	.0	14.8
SW	1.1	2.7	1.1	5.8	.6	1.5	.9	.5	14.2
W	.0	1.5	5.5	12.0	5.7	.4	.0	.0	25.0
NW	.0	1.3	3.1	2.1	.0	.0	.0	.0	6.5
IND	.0	4.3	.5	.0	.0	.0	.0	.0	4.7
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	4.3	30.3	19.9	31.8	10.4	1.9	.9	.3	100.0

NUMBER OF OBS 211 IND=INDETERMINATE

OCT — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

	WAVE HEIGHT (METERS)								
DIR	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	3.9	.8	1.9	4.6	.0	.0	.0	11.3
NE	1.1	3.7	.1	1.4	1.4	.0	.0	.0	9.7
E	.0	.8	.0	.0	.0	.0	.0	.0	.8
SE	.6	.8	2.4	.6	.0	.0	.0	.0	4.3
S	.0	4.7	7.9	.8	.0	.0	.0	.0	13.1
SW	1.1	9.6	7.6	5.3	.0	.0	.0	.0	23.6
W	.0	3.8	5.6	3.9	.0	.0	.0	.0	13.2
NW	.6	2.4	9.3	6.1	.7	.0	.0	.0	19.0
IND	.0	1.7	2.2	1.1	.0	.0	.0	.0	5.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	3.3	33.3	35.6	21.1	6.7	.0	.0	.0	100.0

NUMBER OF OBS 180 IND=INDETERMINATE

SEPT — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

	WAVE HEIGHT (METERS)								
PERIOD IN SECONDS	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	4.3	19.9	2.8	.0	.0	.0	.0	.0	27.0
6-7	.0	4.3	14.7	20.9	5.2	.0	.0	.0	45.0
8-9	.0	1.9	1.9	10.9	5.2	.5	.0	.0	20.4
10-11	.0	.0	.0	.0	.0	1.4	.0	.0	1.4
12-13	.0	.0	.0	.0	.0	.0	.9	.5	1.4
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	4.3	.5	.0	.0	.0	.0	.0	4.7
TOTAL	4.3	30.3	19.9	31.8	10.4	1.9	.9	.3	100.0

NUMBER OF OBS	MAX WAVE HEIGHT PER	MAX WAVE HEIGHT DIR	MAX WAVE HEIGHT TYPE	MAX WAVE HEIGHT DA HR	IND=INDETERMINATE (DIR IN DEGREES)
211	HGT 10.9	12	240	SEA 22 03	

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

OCT — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

	WAVE HEIGHT (METERS)								
PERIOD IN SECONDS	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	3.3	25.7	3.3	.6	.0	.0	.0	.0	33.9
6-7	.0	5.4	28.9	0.1	1.7	.0	.0	.0	42.2
8-9	.0	.0	1.1	10.6	4.4	.0	.0	.0	16.1
10-11	.0	.0	.0	2.8	.6	.0	.0	.0	3.3
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	1.1	2.2	1.1	.0	.0	.0	.0	4.4
TOTAL	3.3	33.3	35.6	21.1	6.7	.0	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT PER	MAX WAVE HEIGHT DIR	MAX WAVE HEIGHT TYPE	MAX WAVE HEIGHT DA HR	IND=INDETERMINATE (DIR IN DEGREES)
180	HGT 9.5	7	280	SEA 03 04	

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 8
CLIMATOLOGICAL DATA

Ocean Weather Station 'DELTA' 44°00'N 41°00'W — September and October, 1972

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
SEPT	10.5	22 06	16.9	22.6	12 16	2.4	30 03	14.1	20.4	12 03	16.3	*30 12	21.1	22.8	*09 09	-11.7	22 06	- 2.2	1.2	12 16
OCT	10.2	12 09	16.4	22.8	02 15	2.6	*12 21	12.3	18.7	04 09	15.9	31 06	18.4	21.1	02 09	- 8.3	29 03	- 2.1	3.4	02 15

MONTH	MEANS AND EXTREMES PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS) TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER RAIN OR DRZL PCPN	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
SEPT	996.2	21 04	1015.5	1032.6	30 12	12.1	22.9	45.8	19.2	32.2	34.1	26.6	7.0	20	20	0	1	0	6	3	1	29	11.7	214
OCT	1004.3	24 19	1022.1	1034.2	02 00	4.4	17.3	33.1	45.2	24.2	22.2	23.8	29.8	13	13	0	0	2	8	1	0	31	12.9	248

** VV-90-93 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

SEPT — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	4.0	7.4	1.6	.0	.0	13.0	19.1
NE	.0	4.2	2.1	.1	.0	.0	6.4	10.1
E	.0	2.3	3.0	.0	.0	.0	5.4	10.7
SE	.0	1.3	1.6	.0	.0	.0	2.9	11.2
S	.4	5.1	5.6	3.2	.0	.3	14.7	15.5
SW	1.1	7.4	4.0	3.8	.3	.0	16.7	16.1
W	.0	2.2	6.9	4.4	2.1	.9	16.6	22.2
NW	.0	1.3	8.2	5.8	4.0	.0	19.5	22.9
CALM	2.8	.0	.0	.0	.0	.0	2.8	.0
TOTAL	4.2	28.0	38.8	21.0	6.5	1.4	100.0	18.9

NUMBER OF OBS 214 — MAX WIND DIR 260, SPEED 66, DA HR 21 0640 — VECTOR MEAN SPEED 8.3, DIR 279 (DIR IN DEGREES)

OCT — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.3	1.4	2.7	4.0	3.4	.0	11.9	24.1
NE	.0	.2	.8	.1	.0	.0	1.1	13.1
E	.4	1.2	1.8	.0	.0	.0	3.4	12.6
SE	.4	4.8	6.6	1.7	.1	.0	13.5	13.0
S	1.0	9.5	14.8	12.4	1.1	.0	38.8	17.6
SW	.2	.7	3.4	2.8	.0	.0	7.2	18.8
W	.0	.8	.4	1.9	.0	.0	3.1	20.5
NW	.1	.8	2.1	9.9	1.8	.4	14.9	23.2
CALM	4.4	.0	.0	.0	.0	.0	4.4	.0
TOTAL	6.9	21.4	32.7	33.5	5.2	.4	100.0	18.[illegible]

NUMBER OF OBS 248 — MAX WIND DIR 330, SPEED 48, DA HR 06 1200 — VECTOR MEAN SPEED 4.0, DIR 215 (DIR IN DEGREES)

Wave

SEPT — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	3.6	5.5	4.8	1.3	.0	.0	.0	15.2
NE	.9	1.4	8.5	4.7	.0	.0	.0	.0	15.5
E	.0	.9	2.5	.0	.0	.0	.0	.0	3.4
SE	.0	.0	1.6	.0	.0	.0	.0	.0	1.6
S	.3	.3	2.6	2.5	.0	.0	.0	.0	6.0
SW	.3	.3	2.3	3.2	.9	.0	.0	.0	7.4
W	.0	.9	9.2	2.5	2.3	.5	.0	.0	15.5
NW	.0	2.3	7.9	4.4	2.3	1.9	.0	.0	19.0
IND	.0	7.5	8.9	.0	.0	.0	.0	.0	16.4
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.9	17.8	49.1	22.0	7.0	2.3	.0	.0	100.0

NUMBER OF OBS 214 — IND=INDETERMINATE

OCT — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	1.4	3.5	3.6	3.5	1.6	.0	.0	13.7
NE	.0	.2	1.4	.4	.0	.0	.0	.0	2.0
E	1.3	.4	1.8	.0	.0	.0	.0	.0	3.7
SE	2.0	8.4	3.2	1.1	.2	.0	.0	.0	14.9
S	1.7	11.9	8.6	4.2	3.6	.0	.0	.0	30.0
SW	.6	1.7	2.4	1.1	.2	.0	.0	.0	6.0
W	.0	.0	.7	1.2	.7	.0	.0	.0	2.6
NW	.0	2.8	9.7	10.8	3.0	.4	.0	.0	26.5
IND	.8	2.8	.8	.0	.0	.0	.0	.0	4.4
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	6.5	29.8	28.2	22.2	11.3	2.0	.0	.0	100.0

NUMBER OF OBS 248 — IND=INDETERMINATE

SEPT — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	1.9	4.2	3.3	.9	.0	.0	.0	.0	10.3
6-7	.0	2.3	12.1	7.9	5.6	.9	.0	.0	29.0
8-9	.0	2.8	22.9	13.1	1.4	1.4	.0	.0	41.6
10-11	.0	.9	1.9	.0	.0	.0	.0	.0	2.8
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	7.5	8.9	.0	.0	.0	.0	.0	16.4
TOTAL	1.9	17.8	49.1	22.0	7.0	2.3	.0	.0	100.0

NUMBER OF OBS 214 — MAX WAVE HEIGHT MET 6.5, PER 6, DIR 300, TYPE SEA, DA HR 21 12 — IND=INDETERMINATE (DIR IN DEGREES)

OCT — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	3.6	22.4	19.7	6.9	1.2	.0	.0	.0	50.0
6-7	.0	3.6	8.9	12.9	4.0	.0	.0	.0	29.4
8-9	.0	.8	4.4	2.4	6.0	2.0	.0	.0	15.7
10-11	.0	.0	.4	.0	.0	.0	.0	.0	.4
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.8	2.8	.8	.0	.0	.0	.0	.0	4.4
TOTAL	6.5	29.8	28.2	22.2	11.3	2.0	.0	.0	100.0

NUMBER OF OBS 248 — MAX WAVE HEIGHT MET 7.0, PER 9, DIR 330, TYPE SEA, DA HR 06 18 — IND=INDETERMINATE (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 9
CLIMATOLOGICAL DATA

Ocean Weather Station 'ECHO' 35°00'N 48°00'W — September and October, 1972

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C)					DEW-POINT TEMP (°C)					SEA TEMP (°C)					AIR-SEA TEMP DIFFERENCE (°C)				
	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR
SEPT	21.2	25 03	24.4	27.0	20 21	12.9	22 06	19.0	23.1	19 21	23.7	25 21	24.8	27.5	14 18	- 3.0	≈02 21	- 1.6	1.0	19 18
OCT	18.3	04 06	22.8	26.0	03 18	6.5	≈07 09	18.5	22.4	02 03	22.3	≈18 09	24.1	26.1	30 09	- 6.1	07 06	- 1.3	1.0	03 16

MONTH	MEANS AND EXTREMES — PRESSURE (MB)					PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS) — TOTAL CLOUD				LOW CLOUD				DAYS WITH SPECIFIED WEATHER — RAIN OR DRIZ	SNOW	THDR	VISBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
	MIN	DA HR	MEAN	MAX	DA HR	0-2	3-5	6-7	8 & OBSC	0-2	3-5	6-7	8 & OBSC	PCPN									
SEPT	1007.6	05 06	1019.4	1025.6	19 00	13.5	37.0	41.0	8.5	40.0	38.0	17.3	4.5	15	15	0	1	0	0	0	0	22	0.0	200
OCT	1010.5	15 06	1019.9	1027.6	12 03	10.5	20.8	36.0	26.7	37.7	32.2	16.9	13.1	22	22	0	0	0	2	0	0	29	10.2	294

** VV=00-03 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

SEPT — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.4	3.3	7.1	2.5	.0	.0	13.3	15.3
NE	.6	3.3	16.8	5.0	.0	.0	25.6	16.9
E	.0	1.9	6.0	2.9	.0	.0	10.8	17.2
SE	.0	2.5	.0	.5	.0	.0	3.0	8.7
S	.4	2.0	.0	.0	.0	.0	2.4	6.4
SW	.1	10.0	4.4	.5	.0	.0	15.0	10.0
W	.5	7.8	6.5	.0	.0	.0	14.8	10.1
NW	.0	6.9	1.8	.1	.0	.0	8.8	8.9
CALM	6.5	.0	.0	.0	.0	.0	6.5	.0
TOTAL	8.5	37.5	42.5	11.5	.0	.0	100.0	12.4

NUMBER OF OBS 200 — MAX WIND DIR 040, SPEED 30, DA HR *26 1400 — VECTOR SPEED 9.0 — MEAN DIR 023 — (DIR IN DEGREES)

OCT — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	4.2	8.9	4.2	.0	.0	17.3	13.7
NE	.0	3.1	7.9	3.0	.0	.0	14.0	16.4
E	.3	3.6	4.3	1.9	.3	.0	10.3	13.2
SE	.1	2.1	15.6	5.4	1.4	.0	24.6	18.0
S	.0	3.2	10.9	1.1	.0	.0	15.1	13.0
SW	.0	2.4	1.8	.1	.0	.0	4.5	10.6
W	.4	4.0	.7	.0	.0	.0	5.2	8.0
NW	.0	4.9	.7	.0	.0	.0	5.6	7.1
CALM	3.4	.0	.0	.0	.0	.0	3.4	.0
TOTAL	4.2	27.5	50.0	15.7	1.7	.0	100.0	14.7

NUMBER OF OBS 294 — MAX WIND DIR 140, SPEED 39, DA HR 01 1500 — VECTOR SPEED 9.8 — MEAN DIR 104 — (DIR IN DEGREES)

Wave

SEPT — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	6.5	9.0	5.0	.4	.0	.0	.0	20.9
NE	.0	3.1	12.0	6.0	.1	.0	.0	.0	23.3
E	.0	3.1	6.4	2.0	.0	.0	.0	.0	11.5
SE	.0	.0	.0	.5	.0	.0	.0	.0	.5
S	.0	.0	.0	.0	.0	.0	.0	.0	.0
SW	.0	4.3	.0	.0	.0	.0	.0	.0	4.3
W	.0	10.6	1.9	.5	.0	.0	.0	.0	13.0
NW	.0	6.4	5.3	.5	.0	.0	.0	.0	12.1
IND	1.0	13.0	.0	.5	.0	.0	.0	.0	14.5
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.0	47.0	34.5	17.0	.5	.0	.0	.0	100.0

NUMBER OF OBS 200 — IND=INDETERMINATE

OCT — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.7	7.5	2.4	8.1	.0	.0	.0	.0	18.8
NE	2.2	6.4	3.7	2.3	.0	.0	.0	.0	15.0
E	1.4	6.8	2.8	.8	.3	.0	.0	.0	14.1
SE	.3	13.0	2.4	3.2	3.5	.0	.0	.0	22.7
S	.0	9.2	4.7	2.1	.0	.0	.0	.0	16.1
SW	.0	1.1	.1	.8	.0	.0	.0	.0	2.0
W	.4	.3	.0	.0	.0	.0	.0	.0	.7
NW	.4	.4	.0	.0	.0	.0	.0	.0	.8
IND	1.3	4.2	4.2	.3	.0	.0	.0	.0	9.7
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	7.2	51.3	20.3	17.4	3.8	.0	.0	.0	100.0

NUMBER OF OBS 294 — IND=INDETERMINATE

SEPT — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	17.0	6.5	1.0	.0	.0	.0	.0	24.5
6-7	.0	10.0	17.0	10.5	.0	.0	.0	.0	37.5
8-9	.0	7.0	10.5	2.0	.5	.0	.0	.0	20.0
10-11	.0	.0	.5	9.0	.0	.0	.0	.0	9.5
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	1.0	13.0	.0	.5	.0	.0	.0	.0	14.5
TOTAL	1.0	47.0	34.5	17.0	.5	.0	.0	.0	100.0

NUMBER OF OBS 200 — MAX WAVE HEIGHT: HGT 4.0, PER 9, DIR 020, TYPE SWL, DA HR 23 19 — IND=INDETERMINATE — (DIR IN DEGREES)

OCT — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	4.2	30.1	4.2	.0	.0	.0	.0	.0	38.6
6-7	1.7	16.5	11.9	16.1	1.9	.0	.0	.0	47.3
8-9	.0	.4	.0	1.3	2.5	.0	.0	.0	4.2
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	1.3	4.2	4.2	.0	.0	.0	.0	.0	9.7
TOTAL	7.2	51.3	20.3	17.4	3.8	.0	.0	.0	100.0

NUMBER OF OBS 294 — MAX WAVE HEIGHT: HGT 9.5, PER 9, DIR 140, TYPE SEA, DA HR 01 21 — IND=INDETERMINATE — (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 10
CLIMATOLOGICAL DATA

Ocean Weather Station 'HOTEL' 38°00'N 71°00'W — September and October, 1972

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
SEPT	16.7	06 06	23.2	26.7	04 18	9.6	11 06	18.1	23.9	08 15	23.8	*12 03	24.9	26.2	*03 00	- 8.0	06 06	- 1.7	1.8	08 18
OCT	8.3	20 12	17.4	23.0	29 12	- .3	20 18	11.6	22.1	29 12	19.7	*26 18	21.9	25.8	14 18	-12.0	20 12	- 4.4	1.2	17 12

MONTH	MEANS AND EXTREMES PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS) TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER RAIN OR DRZL PCPN	SNOW	TSTM	VERY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
SEPT	1004.3	03 00	1015.5	1026.2	11 15	18.9	18.9	43.3	18.9	48.9	25.6	17.5	7.8	9	9	0	0	0	3	0	0	10	12.2	90
OCT	1008.7	29 18	1019.5	1033.7	21 18	5.4	22.4	41.5	30.6	32.0	29.9	27.2	10.9	9	8	0	2	0	4	0	0	18	8.8	147

** VV-90-93 AND/OR W=4 COMP OB DAYS-COMPLETE OB DAYS

Wind

SEPT — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	7.2	8.3	4.4	.8	.0	20.8	16.4
NE	.0	1.4	13.6	11.1	1.7	.0	27.8	20.3
E	.0	2.8	1.1	12.2	.8	.0	16.9	23.8
SE	.0	.0	.0	.0	.0	.0	.0	0.0
S	.0	4.2	.0	2.2	.0	.0	6.4	14.1
SW	.0	2.5	3.3	3.6	.0	.0	9.4	16.5
W	.0	4.7	6.7	.8	.8	.0	13.1	14.2
NW	.0	1.1	2.5	1.1	.3	.0	5.0	17.7
CALM	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	24.4	35.6	35.6	4.4	.0	100.0	18.3

NUMBER OF OBS 90 — MAX WIND DIR 070, SPEED 40, DA HR 02 0905 — VECTOR SPEED 7.7 — MEAN DIR 036 — (DIR IN DEGREES)

OCT — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.5	4.3	12.4	7.5	1.9	.0	26.5	18.4
NE	1.4	4.1	8.2	1.7	.2	.0	17.5	13.3
E	.7	4.3	1.9	.0	.0	.0	6.8	8.9
SE	.0	2.2	1.4	2.2	.0	.0	5.8	14.9
S	.7	.5	2.4	2.9	1.4	.0	7.8	20.9
SW	.0	1.3	8.8	5.1	.0	.0	15.5	19.7
W	.0	1.4	6.5	.0	.0	.0	7.8	14.3
NW	.2	2.2	4.1	3.1	.0	.0	9.5	18.3
CALM	.7	.0	.0	.0	.0	.0	.7	.0
TOTAL	4.1	24.5	45.6	22.4	3.4	.0	100.0	16.5

NUMBER OF OBS 147 — MAX WIND DIR 170, SPEED 43, DA HR 29 0330 — VECTOR SPEED 3.7 — MEAN DIR 340 — (DIR IN DEGREES)

Wave

SEPT — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	11.9	6.4	5.3	.0	.0	.0	.0	23.6
NE	.0	12.5	1.9	1.7	5.3	.0	.0	.0	21.4
E	.0	.8	3.9	1.9	15.3	.0	.0	.0	21.9
SE	.0	.0	.3	1.1	2.8	.0	.0	.0	4.2
S	.0	4.2	6.1	.0	.0	.0	.0	.0	10.3
SW	.0	.3	1.9	.0	.0	.0	.0	.0	2.2
W	.0	.0	5.0	.0	.8	.0	.0	.0	5.8
NW	.0	.3	.0	.0	1.4	.0	.0	.0	1.7
IND	.0	8.9	.0	.0	.0	.0	.0	.0	8.9
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	38.9	29.6	10.0	25.6	.0	.0	.0	100.0

NUMBER OF OBS 90 — IND=INDETERMINATE

OCT — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	13.3	10.5	.5	3.7	.0	.0	.0	28.1
NE	.0	9.2	4.3	1.4	1.7	.0	.0	.0	16.9
E	.0	8.7	.7	.0	.0	.0	.0	.0	9.4
SE	.0	2.7	1.4	.2	.2	.0	.0	.0	4.4
S	.0	1.4	4.3	3.1	3.1	.0	.0	.0	11.7
SW	.0	3.7	5.6	2.9	.9	.0	.0	.0	13.1
W	.0	1.5	1.7	.0	.0	.0	.0	.0	3.2
NW	.0	5.8	3.6	.9	1.4	.0	.0	.0	11.6
IND	.0	2.0	.0	.0	.0	.0	.0	.0	2.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	48.3	32.0	8.8	10.9	.0	.0	.0	100.0

NUMBER OF OBS 147 — IND=INDETERMINATE

SEPT — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	16.7	6.7	.0	.0	.0	.0	.0	23.3
6-7	.0	13.3	16.7	8.9	5.6	.0	.0	.0	44.4
8-9	.0	.0	2.2	1.1	8.9	.0	.0	.0	12.2
10-11	.0	.0	.0	.0	5.6	.0	.0	.0	5.6
12-13	.0	.0	.0	.0	4.4	.0	.0	.0	4.4
>13	.0	.0	.0	.0	1.1	.0	.0	.0	1.1
IND	.0	8.9	.0	.0	.0	.0	.0	.0	8.9
TOTAL	.0	38.9	25.6	10.0	25.6	.0	.0	.0	100.0

NUMBER OF OBS 90 — MAX WAVE HEIGHT HGT 5.0, PER 12, DIR 090, TYPE SWL, DA HR 03 00 — IND=INDETERMINATE (DIR IN DEGREES)

OCT — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	28.6	9.5	.0	.0	.0	.0	.0	38.1
6-7	.0	16.3	17.0	4.1	3.4	.0	.0	.0	40.8
8-9	.0	1.4	5.4	4.8	7.5	.0	.0	.0	19.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	2.0	.0	.0	.0	.0	.0	.0	2.0
TOTAL	.0	48.3	32.0	8.8	10.9	.0	.0	.0	100.0

NUMBER OF OBS 147 — MAX WAVE HEIGHT HGT 5.0, PER 9, DIR 020, TYPE SEA, DA HR 20 09 — IND=INDETERMINATE (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

For each observation, the higher wave of the sea/swell selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 11
Selected Gale Observations, North Atlantic
September and October 1972

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10s	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec	Sea Waves* Height ft	Swell Waves Dir. 10s	Swell Waves Period sec	Swell Waves Height ft
NORTH ATLANTIC		SEP.															
USCGC DUANE	AMERICAN	3	43.9 N	68.0 W	21	07	N 48 (C)	.5 NM	01	1006.6	16.6	17.8	8	13			
SS ESSO PUERTO RICO	PANAMANIAN	3	40.6 N	71.3 W	18	15	N 47 (C)	2 NM	06	999.0	20.0	22.2			36	< 6	11.5
SS SANTA CLARA	AMERICAN	4	15.9 N	71.6 W	06	07	42	10 NM	02	1011.9	28.3	27.2			10	12	11.5
SS ESSO PUERTO RICO	PANAMANIAN	4	41.0 N	70.2 W	00	15	N 47 (C)	2 NM	06	999.0	20.0	22.2			36	< 6	11.5
USCGC DUANE	AMERICAN	4	43.2 N	67.4 W	00	10	N 42 (C)	2 NM	80	1001.2	17.4	17.8	8	14.5			
SS TRANSIDAHO	AMERICAN	11	31.5 N	72.2 W	06	04	50 (D)	10 NM	29	1015.0	26.0	27.8	6	18			
USCGC HAMILTON	AMERICAN	11	44.0 N	53.6 W	15	26	44	5 NM	14	1000.1	14.8	16.6	7	16.5			
MV VEMA R/V	PANAMANIAN	22	60.0 N	31.0 W	18	14	80	5 NM	02	990.5	11.2	9.8	4	11.5	14	>13	29.5
MV VEMA R/V	PANAMANIAN	23	59.7 N	32.5 W	06	18	60	2 NM	02	989.1	10.0	8.4	10	18	18	9	28
SS RIO MANAMO	LIBERIAN	30	36.4 N	31.2 W	12	27	48	10 NM	27	1001.0	7.5	10.0	7	23			
OCEAN STATION VESSELS																	
ATLANTIC B																	
USCGC BOUTWELL	AMERICAN	18	36.6 N	51.1 W	06	14	48	2 NM	63	1002.3	6.8	6.9	7	10			
USCGC BOUTWELL	AMERICAN	19	36.3 N	51.2 W	06	28	62	2 NM	07	1006.7	4.6	7.3	8	23			
USCGC SPENCER	AMERICAN	25	36.3 N	51.0 W	03	32	N 42	5 NM	02	1007.0	3.0	5.9	8	18			
ATLANTIC C																	
USCGC CHASE	AMERICAN	16	32.6 N	35.2 W	03	17	N 43	.5 NM	63	999.5	14.4	10.6	7	13			
USCGC CHASE	AMERICAN	21	32.8 N	33.5 W	12	03	N 45	.25 NM	01	984.6	8.6	11.7	7	13			
USCGC CHASE	AMERICAN	22	32.8 N	35.0 W	03	24	N 62	5 NM	80	976.8	7.8	11.8	12	34.5			
ATLANTIC D																	
USCGC HAMILTON	AMERICAN	6	43.7 N	40.8 W	15	28	N 43	5 NM	15	1001.1	20.3	21.7	6	11.5			
USCGC DUANE	AMERICAN	21	44.0 N	41.0 W	06	26	N 52	2 NM	07	998.2	19.8	21.3	6	18			
USCGC DUANE	AMERICAN	22	44.6 N	43.4 W	06	31	N 41	5 NM	02	1018.0	10.5	22.2	8	16.5			
GREAT LAKES VESSELS																	
SS JOHN DYKSTRA	AMERICAN	7	46.7 N	86.5 W	00	18	N 52	10 NM	02		16.0	14.0	4	6.5			
SS ARMCO	AMERICAN	20	47.2 N	89.2 W	12	16	N 44	5 NM	03		16.0	11.0	8	6.5			
SS JOHN SHERWIN	AMERICAN	21	47.2 N	86.7 W	00	20	N 41	2 NM	18		16.0	11.0	6	11.5			
SS PAUL H CARNAHAN	AMERICAN	21	46.8 N	85.0 W	00	13	N 43	10 NM	02		15.6	11.1	6	8.2			
SS JOHN DYKSTRA	AMERICAN	28	47.6 N	87.6 W	12	16	N 42	2 NM	18		9.0	11.0		8			
NORTH ATLANTIC		OCT.															
MV ATLANTIC FOREST	NORWEGIAN	7	37.1 N	68.0 W	06	13	N 44	2 NM	81	998.0	21.8	24.0		14.5	09	11	19.5
SS EXPORT FREEDOM	AMERICAN	7	44.0 N	34.1 W	12	35	45	5 NM	51	1000.5	16.7	17.8	5	10	33	10	23
SS AMER ALLIANCE	AMERICAN	7	39.0 N	63.7 W	18	14	55	.5 NM	63	992.0	22.2	23.8	14	29.5			
SS EAGLE	AMERICAN	7	38.2 N	40.8 W	18	13	54	.5 NM	07	1006.8	23.3	27.7	12	19.5			
MV NAESS LOUISANA	BRITISH	7	40.3 N	37.8 W	00	34	45	10 NM	03	1003.3	17.3	19.8	11	29.5			
SS AMER ALLIANCE	AMERICAN	8	38.5 N	62.2 W	00	16	55	.5 NM	63	994.9	23.3	26.7	9	29.5			
SS EAGLE	AMERICAN	8	38.5 N	62.6 W	00	13	50	.5 NM	64	1001.4	24.2	27.7	9	19.5			
SS RIO MANAMO	LIBERIAN	8	43.5 N	63.2 W	06	16	48	.25 NM		989.3	19.0	16.8					
SS EXPOR. FREEDOM	AMERICAN	9	43.0 N	65.6 W	18	18	43	1 NM	81	999.7	16.7	11.7	6	6.5	17	10	16.5
MV PHOSPHORE CONVEYOR	LIBERIAN	10	47.7 N	12.3 W	06	31	44	10 NM	18	1010.1	13.3		7	13			
USCGC SPENCER	AMERICAN	10	60.0 N	48.0 W	09	18	N 52	2 NM	07	997.6	5.4	4.2	11	26			
USCGC SPENCER	AMERICAN	16	54.4 N	51.0 W	21	23	47	2 NM	07	979.3	3.1	5.0	8	21			
SS PRES HOOVER (NEW)	AMERICAN	20	35.1 N	73.1 W	00	01	45	2 NM	82	1017.3	13.0	26.7	4	11.5	01	6	14.5
USCGC SPENCER	AMERICAN	20	43.7 N	59.2 W	06	10	52	1 NM	63	1004.2	13.8	12.0	9	26			
MV MAIMAR	BRITISH	21	40.7 N	53.2 W	18	36	44	5 NM	21	1024.3	15.0	22.0	10	11.5			
SS NORMACORACO	AMERICAN	21	34.7 N	67.0 W	00	06	42	5 NM	02	1026.0	15.0	26.7	8	13			
SS AFRICAN STAR	AMERICAN	22	35.5 N	64.5 W	30	03	40	5 NM	02	1020.2	18.9	23.3	8	16.5			
MV FERNGROVE	NORWEGIAN	26	54.0 N	20.9 W	18	34	48	2 NM	25	979.0	7.0	11.0	11	23			
SS AMER LEADER	AMERICAN	26	33.0 N	17.8 W	12	17	50	5 NM	01	969.9	12.8	12.8	5	10	17	< 6	14.5
SS AMER LEADER	AMERICAN	27	34.5 N	21.6 W	12	32	60	1 NM	60	991.0	8.9	12.8	12	39			
OCEAN STATION VESSELS																	
ATLANTIC B																	
USCGC SPENCER	AMERICAN	9	36.6 N	51.0 W	00	12	N 47	1 NM	61	1000.8	5.6	5.6	8	16.5			
USCGC SHERMAN	AMERICAN	16	35.3 N	51.0 W	21	20	N 42	5 NM	15	996.5	3.1	4.4	8	14.5			
ATLANTIC C																	
USCGC OWASCO	AMERICAN	5	32.8 N	35.2 W	06	33	49	1 NM	16	1004.9	7.0	10.6	7	18			
ATLANTIC D																	
USCGC HUNTR	AMERICAN	6	43.8 N	42.0 W	12	33	N 48	5 NM	25	1010.6	12.8	20.0	8	16.5			
GREAT LAKES VESSELS																	
SS ERNEST T WEIR	AMERICAN	8	46.7 N	85.0 W	18	31	N 41	> 25 NM	02		3.0	10.0	4	3			
SS CHARLES M BEEGHLY	AMERICAN	14	42.2 N	81.0 W	18	26	N 49	10 NM	02		11.0	10.0	10	10			
SS RESERVE	AMERICAN	16	47.6 N	89.3 W	18	31	N 46	10 NM	23		2.0	5.0	4	11.5			
SS PAUL H CARNAHAN	AMERICAN	16	45.2 N	83.7 W	18	23	N 41	10 NM	01		11.1	10.0	5	5			
SS ARMCO	AMERICAN	16	47.1 N	90.4 W	18	27	N 42	10 NM	02		9.0	6.0	5	8			
SS ASHLAND	AMERICAN	16	47.0 N	91.3 W	18	28	N 49	10 NM	03		7.0	7.0	4	3			
SS ERNEST R BREECH	AMERICAN	16	47.2 N	89.3 W	12	25	N 42	10 NM	02		5.0	7.0	12	10			
SS LEON FRASER	AMERICAN	16	45.8 N	84.9 W	06	24	N 42	> 25 NM	03		7.0	10.0	6	11.5			
SS LEON FALK JR	AMERICAN	16	47.5 N	87.6 W	18	26	N 52	> 25 NM	02		6.0	7.0	6	11.5			
SS A H FERBERT	AMERICAN	17	47.3 N	90.5 W	00	33	N 42	> 25 NM	02		3.0	6.0	10	8			
SS WILLIAM A IRVIN	AMERICAN	17	45.0 N	83.1 W	00	32	N 48	> 25 NM	21		6.0	10.0	4	6.5			
SS J L HAUTHE	AMERICAN	17	43.9 N	84.4 W	06	28	N 42	10 NM	01		1.0	11.0					
SS JOHN SHERWIN	AMERICAN	17	44.8 N	83.2 W	00	31	N 52	10 NM	14		14.0	11.0	4	10			
SS LEON FALK JR	AMERICAN	17	46.8 N	86.6 W	00	33	N 44	> 25 NM	01		0.0	6.0	7	10			
SS LEHIGH	AMERICAN	17	46.0 N	83.9 W	00	31	N 46	5 NM	01		3.0		5	5			
SS CHARLES M BEEGHLY	AMERICAN	17	47.6 N	87.9 W	00	31	N 48	10 NM	95		- 2.0	7.0	6	16.5			
SS CASAN J CALLAWAY	AMERICAN	24	42.1 N	87.2 W	00	36	N 41	5 NM	52		7.0	11.0	9	13			

\+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind
(C) Tropical storm Carrie
(D) Hurricane Dawn

NOTE: These observations are selected from those with winds of 41 kt or higher. In cases where a ship reported more than one observation a day with such winds, the observation with the highest wind speed was selected. In cases where two or more observations had the same wind speed, the one at 1200 GMT or the one closest to 1200 GMT was chosen. If this method still did not break a tie, the one with the lowest barometric pressure was picked. The data for the Ocean Station Vessels are based on 3-hr observations. In a good many cases, the maximum wind speeds given in the U.S. Ocean Station Climatological Data tables are higher because these are based on the Summary of Day entries.

Table 12
U.S. Ocean Station Vessel Climatological Data
North Pacific

Ocean Weather Station 'NOVEMBER' 30°00'N 140°00'W September and October, 1972

MEANS AND EXTREMES

	DRY BULB TEMP (°C)					DEW-POINT TEMP (°C)					SEA TEMP (°C)					AIR-SEA TEMP DIFFERENCE (°C)				
MONTH	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR
SEPT	19.5	*28 12	21.9	23.7	*15 21	12.7	17 21	16.7	20.2	*26 00	21.6	*17 15	22.7	24.0	07 00	- 3.1	15 06	- .8	.7	12 21
OCT	17.2	26 15	20.4	24.0	03 21	10.6	13 00	15.0	19.3	04 06	20.8	*30 15	21.9	23.4	*08 03	- 4.2	15 18	- 1.5	.8	03 21

	MEANS AND EXTREMES					PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS)								DAYS WITH SPECIFIED WEATHER														
	PRESSURE (MB)					TOTAL CLOUD				LOW CLOUD				RAIN OR DRZL			SNOW	THDR	VSBY <1KM	WIND (KTS) **			COMP OBS DAYS	%OBS WITH PCPN	NO OF OBS
MONTH	MIN	DA HR	MEAN	MAX	DA HR	0-2	3-5	6-7	8 & OBSC	0-2	3-5	6-7	8 & OBSC	PCPN						≥34	≥48	≥64			
SEPT	1016.1	12 15	1020.7	1025.8	*24 18	24.6	26.7	36.2	12.5	44.6	25.0	21.3	9.2	11	11	0	0	0	0	0	0	0	30	2.9	240
OCT	1016.9	09 03	1022.0	1027.5	31 18	15.3	31.3	29.7	20.7	24.4	31.7	28.0	15.9	8	8	0	0	0	0	0	0	0	29	1.6	248

** VV-00-03 AND/OR W=4 COMP OB DAYS-COMPLETE OB DAYS

Wind

SEPT WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

	WIND SPEED (KNOTS)								
DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	4.2	7.5	.0	.0	.0	11.7	11.9
NE	2.1	19.1	29.8	2.1	.0	.0	43.0	12.8
E	3.7	14.4	6.9	.0	.0	.0	24.0	8.8
SE	.8	7.9	9.4	.0	.0	.0	17.9	10.8
S	.0	.0	.0	.0	.0	.0	.0	.0
SW	.0	.0	.0	.0	.0	.0	.0	.0
W	.0	.0	.0	.0	.0	.0	.0	.0
NW	.0	.9	.0	.0	.0	.0	.9	7.4
CALM	2.8	.0	.0	.0	.0	.0	2.8	.0
TOTAL	7.9	42.5	47.5	2.1	.0	.0	100.0	11.0

NUMBER OF OBS	MAX WIND DIR	MAX WIND SPEED	MAX WIND DA HR	VECTOR SPEED	VECTOR MEAN DIR	(DIR IN DEGREES)
240	060	26	*28 1200	8.2	062	

OCT WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

	WIND SPEED (KNOTS)								
DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.4	5.0	5.5	.0	.0	.0	10.9	11.0
NE	.8	8.6	19.6	2.1	.0	.0	31.2	14.4
E	.8	10.4	18.7	2.2	.0	.0	32.1	13.8
SE	.0	9.0	4.9	.1	.0	.0	14.0	10.1
S	.4	.7	1.7	.0	.0	.0	2.8	10.8
SW	.3	.0	.0	.0	.0	.0	.3	3.0
W	.3	.0	.0	.0	.0	.0	.3	3.0
NW	.4	2.0	.0	.0	.0	.0	2.4	6.7
CALM	3.7	.0	.0	.0	.0	.0	3.7	.0
TOTAL	9.3	35.8	50.4	4.5	.0	.0	100.0	12.2

NUMBER OF OBS	MAX WIND DIR	MAX WIND SPEED	MAX WIND DA HR	VECTOR SPEED	VECTOR MEAN DIR	(DIR IN DEGREES)
248	070	25	*23 0700	9.3	068	

Wave

SEPT WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

	WAVE HEIGHT (METERS)									
DIR	<1	1-1.8	2-2.8	3-3.5	4-5.8	6-7.5	8-9.5	>9.5	TOTAL
N	2.3	9.5	2.1	.0	.0	.0	.0	.0	13.9
NE	7.3	31.8	7.7	.0	.0	.0	.0	.0	46.8
E	5.5	13.2	1.0	.0	.0	.0	.0	.0	19.8
SE	3.1	14.4	.0	.0	.0	.0	.0	.0	17.5
S	.0	1.1	.0	.0	.0	.0	.0	.0	1.1
SW	.0	.0	.0	.0	.0	.0	.0	.0	.0
W	.0	.0	.0	.0	.0	.0	.0	.0	.0
NW	.9	.0	.0	.0	.0	.0	.0	.0	.9
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	19.2	70.0	10.8	.0	.0	.0	.0	.0	100.0

NUMBER OF OBS 240 IND-INDETERMINATE

OCT WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

	WAVE HEIGHT (METERS)									
DIR	<1	1-1.8	2-2.8	3-3.8	4-5.8	6-7.8	8-9.5	>9.5	TOTAL
N	2.1	13.1	1.1	.0	.0	.0	.0	.0	16.4
NE	2.5	27.9	7.7	1.2	.0	.0	.0	.0	39.4
E	4.2	13.9	4.9	.0	.0	.0	.0	.0	24.0
SE	.1	8.7	.1	.0	.0	.0	.0	.0	8.9
S	.0	1.4	.0	.0	.0	.0	.0	.0	1.4
SW	.0	.0	.0	.0	.0	.0	.0	.0	.0
W	.0	.0	.0	.0	.0	.0	.0	.0	.0
NW	1.6	4.9	.8	.0	.0	.0	.0	.0	7.3
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	10.6	74.0	14.2	1.2	.0	.0	.0	.0	100.0

NUMBER OF OBS 248 IND-INDETERMINATE

SEPT WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS)									
	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	10.8	11.7	.4	.0	.0	.0	.0	.0	22.9
6-7	2.5	9.2	10.0	.0	.0	.0	.0	.0	21.7
8-9	5.8	48.8	.4	.0	.0	.0	.0	.0	55.0
10-11	.0	.4	.0	.0	.0	.0	.0	.0	.4
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	19.2	70.0	10.8	.0	.0	.0	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR	IND-INDETERMINATE (DIR IN DEGREES)
240	2.5	6	060	SEA	28 15	

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

OCT WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS)									
	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	10.6	24.4	1.2	.0	.0	.0	.0	.0	36.2
6-7	.0	37.6	8.1	.4	.0	.0	.0	.0	36.2
8-9	.0	22.0	4.9	.8	.0	.0	.0	.0	27.6
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	10.6	74.0	14.2	1.2	.0	.0	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR	IND-INDETERMINATE (DIR IN DEGREES)
248	3.5	8	060	SEA	26 15	

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 13
Selected Gale Observations, North Pacific
September and October 1972

Vessel	Nationality	Date	Position of Ship: Lat. deg.	Position of Ship: Long. deg.	Time GMT	Wind: Dir. 10's	Wind: Speed kt	Visibility	Present Weather code	Pressure mb	Temperatures °C: Air	Temperatures °C: Sea	Sea Waves: Period sec.	Sea Waves: Height ft	Swell Waves: Dir. 10's	Swell Waves: Period sec.	Swell Waves: Height ft
NORTH PACIFIC		SEP.															
SS PHIL MAIL	AMERICAN	7	50.9 N	168.5 E	00	23	43	5 NM	16	996.9	11.7	11.1	12	32.5			
MV SALLY MAERSK	DANISH	13	33.7 N	153.5 E	06	04	41	> 25 NM	02	1011.0	24.5	27.0	7	19.5	03	10	23
MV SALLY MAERSK	DANISH	14	33.4 N	160.5 E	06	03	41	5 NM	81	1011.0	24.0	26.0	7	19.5	03	7	23
SS AMER MAIL	AMERICAN	16	34.3 N	142.0 E	18	16	75	5 NM	28	1002.4	23.8	25.3	13	19.5			
SS JAPAN MAIL	AMERICAN	16	34.2 N	140.3 E	18	15	49	10 NM	02	1001.0	24.4	25.0	9	14.5	15	>13	19.5
USNS SILAS BENT	AMERICAN	17	53.4 N	176.0 E	00	08	N 48	2 NM	07	1018.0	8.9	8.9	6	6.5	09	>13	16.5
SS AMER MAIL	AMERICAN	17	34.2 N	144.5 E	00	18	45	5 NM	02	1006.4	26.1	25.0	8	16			
SS SEATRAIN OHIO	AMERICAN	24	29.5 N	175.8 W	18	22	45	5 NM	28	1005.1	24.5	26.5	5	10.5	27	< 6	24.5
SS WASHINGTON MAIL	AMERICAN	24	35.7 N	141.1 E	06	36	49 (I)	2 NM	28	994.9	23.3	26.7	6	13	XX	X	16.5
MV LORD OF THE ISLE	GERMAN	25	34.1 N	139.8 E	06	21	32 (I	2 NM	01	1002.2	26.1	24.0	10	13			
SS GOPHER STATE	AMERICAN	26	36.5 N	159.8 E	00	29	35 (I)	5 NM	40	999.2	22.2	24.4	14	39			
MV GREAT PEACE	PANAMANIAN	26	40.0 N	162.6 W	18	17	N 45	.5 NM	42	1003.5	19.5	20.0	10	16			
SS ARCTIC TOKYO	LIBERIAN	26	53.5 N	177.4 W	00	04	45	1 NM	80	992.0	8.5	9.0	8	39			
SS J H MAC GAREGILL	AMERICAN	27	35.8 N	162.0 W	18	18	30	10 NM	02	1012.9	22.8	21.1					
MV HIZUKAWA MARU	JAPANESE	27	43.2 N	165.8 W	18	23	42	5 NM	02	998.6	18.5	18.0	7	21			
MV PENDRECHT	NETHERLANDS	27	36.2 N	168.1 W	03	20	46	2 NM	63	995.9	21.6	21.8	10	16.5			
SS J H MAC GARGILL	AMERICAN	28	33.4 N	163.0 W	18	18	30	5 NM	64	1013.1	21.7	21.1	14	16.5			
SS JAPAN MAIL	AMERICAN	28	30.0 N	165.4 W	00	16	45	5 NM	01	998.0	12.8	10.0	4	10	15	>13	19.5
NORTH PACIFIC		OCT.															
SS PHIL MAIL	AMERICAN	1	54.1 N	192.5 W	18	01	43	1 NM	53	984.0	6.2	10.6	5	14.5			
MV ATLANTIC PHOENIX	BRITISH	1	44.5 N	177.3 W	00	28	42	2 NM	60	1002.5	12.0	9.0	10	16.5			
SS ESSO NEWARK	AMERICAN	2	35.9 N	146.9 W	18	25	55	5 NM	20	995.6	9.2	8.8	10	32.5			
SS PHIL MAIL	AMERICAN	2	34.3 N	155.1 W	00	33	45	10 NM	01	992.2	6.1	10.0	6	11.5	33	9	19.5
MV SAMUEL S	LIBERIAN	2	52.7 N	154.2 W	00	34	41	5 NM	52	992.0	7.5	9.0	12	29.5			
SS ESSO NEWARK	AMERICAN	3	53.9 N	143.4 W	06	26	45	10 NM	01	1014.0	7.9	10.0	12	32.5			
SS PHILLIPS LOUISIANA	LIBERIAN	3	36.8 N	168.1 E	12	09	44	1 NM	60	1000.1	18.9	24.4	5	6.5			
MV GEORGIANA	LIBERIAN	4	47.6 N	128.1 W	00	32	N 42	10 NM	02	1030.5	12.0	13.0	15	24.5			
SS SANTA ALICIA	AMERICAN	4	41.6 N	124.9 W	12	01	45	10 NM	01	1013.8	11.7						
MV EASTERN BUILDER	LIBERIAN	6	46.0 N	161.1 E	00	18	42	1 NM	63	1015.0	15.0	15.0	9	26			
SS PRES WILSON	AMERICAN	6	34.0 N	143.0 E	12	32	35	5 NM	02	999.0	20.0	24.4		10			
USNS PURMAN	AMERICAN	7	18.7 N	153.8 E	12	02	N 43 (M)	10 NM	30	998.6	27.8	28.9	5	13	04	>13	26
MV TOYOTA MARU # 10	JAPANESE	7	39.6 N	163.6 W	06	02	N 44	2 NM		1020.4	17.3	19.0					
USNS PURMAN	AMERICAN	8	18.9 N	153.8 E	06	08	N 75 (M)	2 NM	30	987.1	26.1	29.4	8	23	09	>13	29.5
MV EASTERN BUILDER	LIBERIAN	8	49.3 N	178.0 E	06	21	55	1 NM	60	997.5	12.0	10.0	9	16.5			
MV GEORGIANA	LIBERIAN	9	52.0 N	169.8 W	06	18	N 48	5 NM	18	1011.4	9.5	8.0	8	26			
SS PACIFIC BEAR	AMERICAN	9	44.3 N	161.2 W	00	08	43	5 NM	02	1021.3	13.8	14.4	4	14.5			
MV GEORGIANA	LIBERIAN	11	50.1 N	177.0 E	06	25	N 72	5 NM	02	988.5	7.0	8.0	XX	49			
MV ROBERTS BANK	LIBERIAN	11	53.3 N	152.1 W	12	19	49	1 NM	07	1004.6	10.8	10.0					
SS EXPORT COMMERCE	AMERICAN	12	32.4 N	151.2 E	00	18	90 (M)	.25 NM	18	990.5	26.2	23.3	XX	47.5			
MV SAMUEL S	LIBERIAN	12	42.2 N	150.2 E	18	34	50 (M)	.5 NM	52	984.5	12.0		14	29			
MV GEORGIANA	LIBERIAN	12	49.7 N	174.5 E	00	31	N 56	10 NM	02	1010.0	6.5	9.0	XX	46			
MV IGUAPE	LIBERIAN	13	49.2 N	161.5 E	12	12	50 (M)	5 NM	02	1002.0	7.2	7.0	9	29			
MV SAMUEL S	LIBERIAN	13	41.4 N	149.8 E	00	28	45 (M)	5 NM	01	999.5	14.0	16.0	10	24.5			
SS PRES GARFIELD	AMERICAN	14	42.1 N	152.7 W	12	12	39	2 NM	60	1003.2	18.3	18.9	5	16.5	12	8	19.5
SS MONTANA	AMERICAN	14	33.8 N	154.8 W	00	20	41	5 NM	01	1005.4	22.8	23.9	12	13			
MV VAN ENTERPRISE	LIBERIAN	15	49.5 N	172.0 W	06	32	N 48	5 NM	52	981.0	5.0	7.0	XX	19.5			
MV KANAGAWA MARU	JAPANESE	15	40.9 N	157.9 W	18	19	N 46	1 NM	81	1000.5	19.0	18.5	11	13			
MV GEORGIANA	LIBERIAN	15	42.9 N	158.4 E	00	27	N 46	10 NM	03	1013.5	12.5	13.0	9	46			
SS AMER MAIL	AMERICAN	16	35.6 N	174.8 W	00	32	42	2 NM	28	982.1	8.0	9.5	7	6	32	10	29.5
MV ROBERTS BANK	LIBERIAN	17	44.3 N	156.5 E	12	24	50	10 NM	03	999.0	10.0		XX	14.5			
SS WASHINGTON MAIL	AMERICAN	18	30.1 N	178.1 E	06	20	45	5 NM	02	992.9	8.9	8.3	4	3	28	< 6	10
MV TRANSOCEAN TRANSPORT	PHILIPPINE	18	45.6 N	162.7 E	00	27	N 43	.5 NM		997.0	11.0	11.3	8	26			
SS PRES TYLER	AMERICAN	20	32.3 N	134.0 E	00	07	49	10 NM	02	1016.6	21.7	24.7	6	13	09	6	16
MV TRANSOCEAN TRANSPORT	PHILIPPINE	20	40.8 N	158.2 E	12	32	N 42	5 NM	02	1017.5	10.0	10.7	8	24.5			
SS ILLINOIS	AMERICAN	21	41.4 N	179.4 E	18	32	45	5 NM	03	998.6	11.1	17.8	6	13			
SS ILLINOIS	AMERICAN	22	41.5 N	171.1 W	18	30	60	2 NM	63	999.3	10.0	18.3			30	>13	26
SS OREGON MAIL	AMERICAN	22	51.7 N	140.8 W	00	20	39	1 NM	31	998.6	10.0	6.6	6	29	20	>13	49
SS CANADA MAIL	AMERICAN	23	39.6 N	152.6 E	00	16	45	1 NM	64	1007.8	20.6	19.8	9	16			
SS HONGKONG CLIPPER	LIBERIAN	23	44.1 N	151.4 E	00	20	50	< 50 YD	59	998.6	14.5	10.0	12	26			
SS OREGON MAIL	AMERICAN	24	54.2 N	162.9 W	00	32	50	> 25 NM	01	1010.2	6.0	3.2					
SS PANAMA	AMERICAN	25	38.1 N	164.0 W	12	05	43	5 NM	03	1017.6	15.0	19.9	8	11.5			
SS AMER LANCER	AMERICAN	26	16.2 N	155.9 E	12	14	52 (O)	5 NM	02	1004.2	28.3	27.3	8	16.5			
SS SGT ANDREW MILLER	AMERICAN	26	18.3 N	153.7 E	06	03	50 (O)	10 NM	02	1001.7	27.8	28.9	4	13	08	9	26
SS PRES TYLER	AMERICAN	26	42.2 N	169.6 W	12	02	41	5 NM	61	1016.6	9.4	15.6	6	13			
SS OREGON MAIL	AMERICAN	27	46.3 N	152.2 E	18	16	49	2 NM	62	989.9	6.0	2.3	3	14.5	16	>13	24.5
MV CECILIE MAERSK	DANISH	27	19.4 N	157.3 E	18	21	(O)	10 NM	09	1008.0	26.3	28.0	8	29.5			
MV CECILIE MAERSK	DANISH	28	18.8 N	150.4 E	00	15	44 (O)	10 NM	25	1010.8	28.6	27.5	7	34.5			
MV HONSHU MARU	JAPANESE	28	45.4 N	159.3 E	06	28	N 43	2 NM	02	1010.5	9.0	10.0	8	16.5			
SS OREGON MAIL	AMERICAN	28	45.5 N	150.7 E	00	27	45	10 NM	01	1002.7	6.1	0.6	3	13	27	>13	24.5
SS AMER ARCHER	AMERICAN	29	30.9 N	152.9 E	12	16	45 (O)	5 NM	01	1008.5	23.5	23.3	8	16.5	13	10	19.5
MV GOLDEN LIGHT	LIBERIAN	29	30.1 N	173.7 E	12	30	N 50	200 YD	03	1008.0	7.0	8.0	7	16.5			
MV LAKE BYRE	SWEDISH	29	33.3 N	149.5 E	12	13	50 (O)	2 NM	07	972.0		24.0					
SS UNIVERSE KURE	LIBERIAN	29	31.3 N	146.0 E	12	29	56 (O)	10 NM	02	999.3	23.0	24.3	8	19.5			

\+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind
(I) Typhoon Ida
(M) Typhoon Marie
(O) Typhoon Olga

NOTE: These observations are selected from those with winds of 41 kt or higher. In cases where a ship reported more than one observation a day with such winds, the observation with the highest wind speed was selected. In cases where two or more observations had the same wind speed, the one at 1200 GMT or the one closest to 1200 GMT was chosen. If this method still did not break a tie, the one with the lowest barometric pressure was picked. The data for the Ocean Station Vessels are based on 3-hr observations. In a good many cases, the maximum wind speeds given in the U.S. Ocean Station Climatological Data tables are higher because these are based on the Summary of Day entries.

Rough Log, North Atlantic Weather
December 1972 and January 1973

ROUGH LOG, DECEMBER 1972--The primary storm track across the North Atlantic was not hard to determine this month. It was fairly diffuse coming across the North American continent, but converged off the U. S. East Coast. The primary track then extended east-northeastward from south of Nova Scotia, to between Iceland and Scotland, and into the Norwegian Sea. A secondary track came out of Canada to south of Kap Farvel and up the Denmark Strait. One LOW raced from the Azores, across Iceland, and near the Svalbard Islands. No significant storms penetrated into the European continent south of 50°N. This compared favorably to the main climatic tracks, except in the Mediterranean area.

The configuration of the mean sea-level pressure over the ocean was very near the climatic pattern. The Icelandic Low was at 62°N, 30°W, slightly east of its normal location. The mean pressure was 985 mb, significantly lower than the normal of 1000.7 mb. The center of the Azores High was almost exactly where climatology places it, except the central pressure was 1025 mb, 4 mb higher than normal. The result of the pressures of the Low being lower, and the High, higher, was a 20-mb tighter gradient. To add to this tight gradient in the north-south direction, there were two closed high-pressure areas where normally there are only ridges; one in central Canada and one over Romania. Therefore, the gradient in the east-west direction, out of the Low center, was greater.

Needless to say, there were large pressure anomalies. A negative 16-mb anomaly was centered southwest of Iceland at 61°N, 24°W. The three major positive anomalies were: 14 mb near 47°N, 22°E (Romania); 11 mb near 55°N, 71°W (central Quebec); and an elongated 5 mb along 30°N, from 10° to 60°W (approximately from Bermuda to Morocco). These pressure differentials and the tighter gradient help account for the concentration of storm tracks and the lack of storms into continental Europe, the Mediterranean Sea, and North Africa.

Tropical cyclones rarely occur during December. In the 30-yr period since 1942, only two have been recorded, and only one of these reached hurricane strength.

From the discussion above, it is probably obvious that there would be numerous storms across the North Atlantic, and that they would be more severe than usual. Indeed, this was true. On November 30, a front was off the U.S. East Coast with a small wave in the Gulf of Mexico. By December 1, this wave had raced across Florida and up the East Coast (fig. 32). As usually happens, the LOW deepened significantly as it passed the vicinity of Cape Hatteras, and at 0000 it was just east of Norfolk with a central pressure of 1003 mb. Twenty-four hours later, at 0000 on the 2d, the LOW was over Anticosti Island in the Gulf of St. Lawrence at 962 mb. The drilling rig, SEDCO 1, reported 50-kt winds and 15-ft seas, the ADMIRAL CALLAGHN was buffeted by 45-kt gales and swells of 15 ft. At 1200 on the 2d, only 12 hr later, the central pressure had dropped to 948 mb, near Hamilton Inlet. The MANCHESTER QUEST was pounded by 50-kt winds with seas of 20 ft and swells of 33 ft, near 53°N, 47°W, almost due east of the storm's center. Ocean Station Vessel "B" and the ship VGBZ shared 45-kt gales. The TOPDALSFJORD experienced 40-kt gales, and the DART ATLANTIC, farther to the southeast, felt 35-kt gales. Many coastal stations were pounded by 35- to 40-kt winds. The 3,318-ton Israeli motor vessel LEORA proceeded to Miquelon Island to renew lashings for containers on the foredeck, broken by very bad weather.

In the next 24 hr, there were 29 reports of winds of 35 kt or greater in the vicinity of the storm, mostly south and east of the center. On the 3d, the following ships battled 50- to 60-kt winds, accompanied by seas and swells up to 40 ft: the USCGC BOUTWELL, EMILIA RUSELLO, PHOTINIA, and ZABRZE. These higher winds and waves were 300 to 800 mi south and east of the LOW's center. At 0600 on the 3d, the storm spawned another center on the front, about 120 mi southeast of Kap Farvel. This new LOW center raced off to the east with the front, while the parent LOW remained stationary about 250 mi southwest of the Cape. With the double low system, the gradient loosened slightly and only one ship, the ZABRZE, reported battling 60-kt winds and 36-ft seas. The C. P. EXPLORER, CHEVRON AMSTERDAM, and YOULIOUSS YANONISS, all were hounded by 45-kt gales, and seas or swells up to 33 ft. On the 4th, the new LOW had developed two additonal centers, and the parent low, now south of Greenland, was moving eastward and rapidly filling. On the 5th and 6th, a broad band of high winds stretched from shore to shore between 45° and 55°N. The AMERICAN LEADER, CAPE FRANKLIN, and the PECAN all battled against 50-kt winds and seas to 25 ft, from Newfoundland to Ireland. One ship, reporting only a three-letter code, was rocked by 33-ft waves. At this time, the three LOWS were moving eastward and filling. Gale-force winds continued to be reported through the 7th. Further disintegration continued on the 8th and 9th, as the now diffuse LOWS were over the Barents Sea. On the 10th, the 10,381-ton Liberian motor vessel GEM returned to Dunkirk with extensive weather damage and the no. 4 hold flooded.

On the 6th, a 1010-mb LOW that developed in the midwest on the 5th moved across the Great Lakes. By 1200 on the 7th, it was centered over Cape Chidley with a pressure of 982 mb. Winds of 40 kt were being reported ahead of the front, as it passed off the coast. Among these reports were Ocean Station Vessels "B" and "H" and ship VGBZ. On the 8th, the original LOW moved slowly northeastward, and a new LOW was spawned over the tip of Greenland. A very tight gradient (6 mb per 100 mi) had developed and the winds were blowing in direct proportion. Only a few ships reported in the area, but the ANARIS and the USCGC HAMILTON were banged by 50-kt winds, with the ANARIS reporting 33-ft seas farther to the east.

On the 9th, the two LOWS registered the same pressure of 967 mb, as they straddled southern Greenland. The NANOK S., east of Kap Farvel, was rolled by a 60-kt crosswind, and the USCGC BOUTWELL and HAMILTON, both near 51°N, 48°W, reported up to

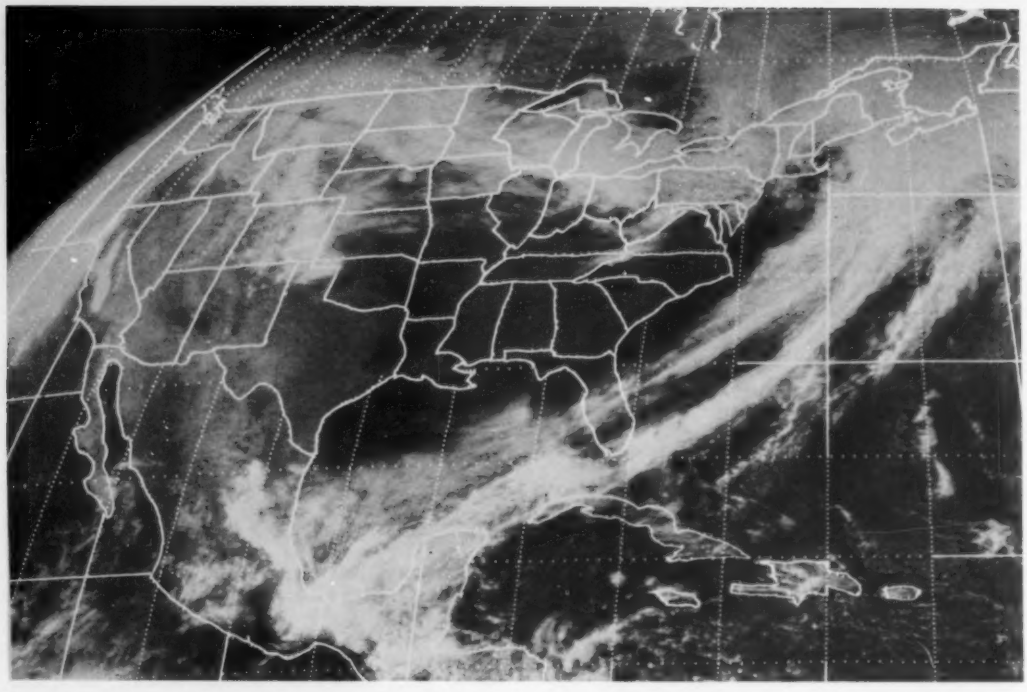

Figure 32.--The ATS-3 satellite depicts the LOW off Cape Cod late on September 1, as it moved up the East Coast after deepening near Cape Hatteras. The cold front trails southwest of the center with a cloud band behind the front where the cold air passes over the warmer water.

55-kt gales and 25-ft seas. At 1200, the ANARIS was making little headway, bucking directly into 70-kt hurricane-force winds and seas of 50 ft. Early on the 10th, both these LOWS were unidentifiable and a new one formed on the front, farther east over Iceland. In this process, the central pressure had risen to 974 mb with a slackening of the gradient. Winds of 45 kt were still occurring along 50°N. At 0000 on the 10th, another LOW had moved up the U.S. coast and was over Newfoundland. It moved rapidly northeastward and 48 hr later was centered 150 mi south of Iceland with a 944-mb center. In the meantime, the 974-mb LOW over Iceland on the 10th moved southwestward and was again near Kap Farvel. The WEATHER MONITOR, near 58.5°N, 14.0°W, reported 55-kt gales at 0000 on the 12th.

A third LOW followed on the heels of the second, out of the U.S. East Coast late on the 10th. By 0000 on the 12th, it was located near 47.5°N, 37.0°W, with a pressure of 972 mb. Ocean Station Vessel "D" was pounded by 60-kt winds as the LOW passed to the north. As this new LOW moved northeastward, it absorbed the two LOWS which preceded it. At 0000 on the 13th, the pressure was 944 mb. On the 12th and 13th, high winds were reported all across the North Atlantic, north of 40°N and south of 55°N. Included among these reports was Ocean Station Vessel "J", which was hammered by winds from 45 to 65 kt and mountainous waves of 40 to 50 ft. The TAIFUN, traveling eastward, north of the Azores Islands, was hounded by 50-kt winds. The UPDV, just east of Newfoundland, rode out 60-kt winds. The LOW continued moving northeastward, as a wave that had formed near the Azores on the 13th moved north, and a lessening of the gradient over the whole area occurred. By the 15th, the LOW had filled considerably and moved into the Zemlya Sea.

Monster of the Month--The "midwife" of so many Atlantic storms, the Texas-Oklahoma Panhandle delivered a 1013-mb depression on the 12th. By 0000 on the 13th, it had grown to 1005-mb and was over the Great Lakes. It was not until 1200 on the 14th, that the LOW became of age and showed its true character. At that time, the LOW had raced due east from Nova Scotia and was near 46.5°N, 41.0°W, with a central pressure of 960 mb. The SSG, 400 mi to the south-southwest was headed directly into 65-kt hurricane-force winds. She was also being rocked and pounded by 35-ft seas and 40-ft swells. She was not alone as the LOVERVAL, near 43.5°N, 37.5°W, had 60 kt, the ECKERT OLDENDORFF near the SSG, only experienced 55 kt, and the BUNTENTOR, a mere 50-kt winds. Ocean Station Vessel "D" was managing to stay close to her station and contend with 70-kt hurricane-force winds and 35-ft seas. The West German motor vessel RUMBA reported that she was in distress 200 mi southeast of Cape Race, Newfoundland, due to locomotives adrift in her lower holds. A Canadian Forces helicopter rescued 12 crewmen from her decks.

On the 15th, the LOW started tracking to the north-

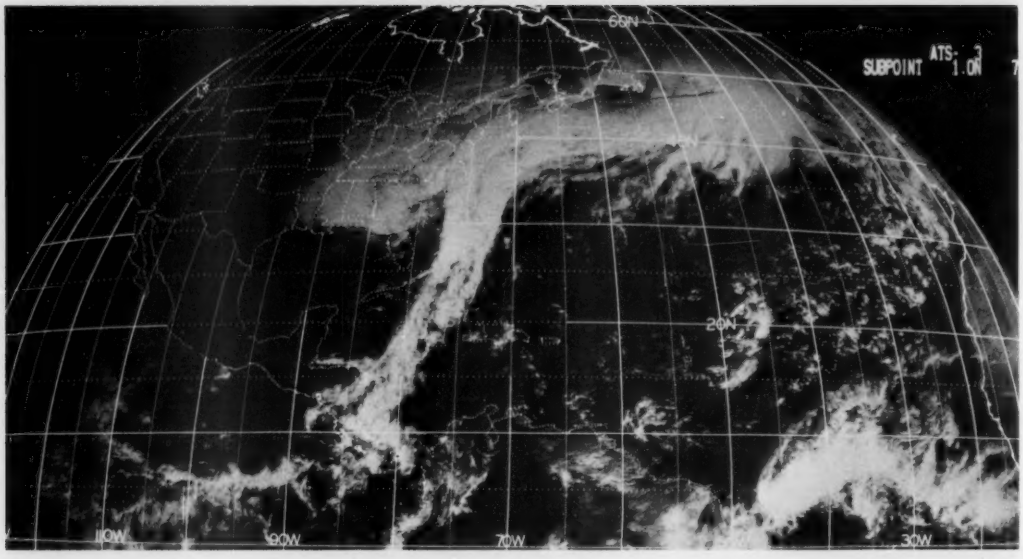

Figure 33.--This ATS-3 photograph, at 1400 on the 23d, shows two LOWS, one east of Newfoundland and the other off the Virginia coast.

east at a slower pace. By 0000 on the 16th, the storm was located at 52°N, 32°W, and its lowest pressure was 946 mb. The strongest wind band remained in the southwest quadrant with winds over 50 kt being reported as far as 600 mi from the center. The BUNTENTOR, ECKERT OLDERDORFF, LOVERVAL, and Ocean Station Vessel "D" had no respite from 60- and 65-kt winds. A new ship joined their ranks, with 70-kt winds and 52-ft waves at 46°N, 36°W. The storm was dominating the whole North Atlantic, north of 35°N and south of 60°N. On the 16th, the LOW started to fill; it rested by making a small loop near 50°N, 30°W. She was still packing a big punch as the ATLANTIC COGNAC reported being walloped by 90-kt winds at 50°N, 36°W, about 150 mi southwest of the center. The C. P. VOYAGEUR reported 50-kt and the UYLG 60-kt winds, 250 and 400 mi, respectively, west of the LOW. Five hundred miles to the south, the ECKERT OLDERDORFF was still fighting 50-kt winds and 30-ft seas, as was the HOFCHST, about 500 mi farther south. The LOW was again tracking northward and then northwestward to combine with another LOW near Kap Farvel on the 18th that had tracked out of the Gulf of St. Lawrence.

A wave on the polar front formed in Georgia on the 14th. It moved northeastward up the coast and, early on the 16th, was off the Delmarva Peninsula with a pressure of 1000 mb. To the north, off Long Island, the GYPSUM PRINCE and the KUNGSHOLM reported 45-kt gales with rain and thunderstorms. Wind gusts up to 45 kt were reported along the New England coast with some surf and wind damage. This was only the beginning. On the 17th at 1200, the pressure had dropped to 962 mb over Anticosti Island, and winds up to 50 kt were being reported to the east, south, and southwest of the center. The ship reports included the ATLANTIC CHAMPAGNE, ATLANTIC COGNAC, BAKAR, EDINBURGH CASTLE, EURPOA, GREAT REPUBLIC, MANIPUR, MERSE LLOYD, MINERAL OUGREE, PHYLLIS BOWATER, SEDCO, SEDNETH, USCGC DALLAS, and Ocean Station Vessel "H."

The LOW tracked northeasterly and by 0000 on the 19th had absorbed the previously described LOW, and was then over Kap Farvel at a pressure of 950 mb. The ELBE EXPRESS and Ocean Station "B" braved 65- to 50-kt winds reporting seas and swells to 33 ft. The LOW continued into the Denmark Strait with only mild gales of 45 kt being reported. Many of these reports included snow showers with temperatures near freezing or below. The northeast and eastward movement continued at a fast rate for the Arctic and on the 22d the LOW was well into the Barents Sea.

This LOW, born in the deep south over Georgia on the 22d, followed in the foot tracks of many others and raced up the east coast at an average speed of 50 kt. At 0000 on the 23d, the pressure was 992 mb and centered near 45°N, 61°W. As the storm passed south of Newfoundland (fig. 33), the GORREDYK and SEDCO I and J reported 40- to 45-kt gales. The LOW passed directly over Ocean Station Vessel "C," at 0000 on the 24th, and the DUNBLANE was battered by 50-kt winds and 33-ft swells near 50°N, 41°W. Twelve hours later, she was still battling 50-kt winds. The ATLANTIC STAR, JUDITH SCHULTE, MANCHESTER QUEST, and MESKUPAS ADOMAS reported 50- and 55-kt winds within a 500-mi radius of the storm.

The storms during this time did not develop the large area of circulation and influence as those earlier in the month, as several were located in the North Atlantic at the same time. The LOW tracked first toward the northeast, and then the north, and was located south of Iceland on Christmas Day. It passed over Iceland, early on the 27th, and into the

Norwegian Sea, on the 28th, where it became part of the general low-pressure trough.

This storm formed near Cape Hatteras as a 1007-mb LOW on the 23d (fig. 33), fast on the heels of the previous storm. It took a more easterly course, and at 1200 on the 24th was near 41°N, 60°W at 1000 mb. The wind report from the CARCHESTER was received as 90 kt, 100 mi east of the low center. The storm continued tracking mostly eastward and was the southernmost of the significant storms this month, except for a LOW that formed near the Azores and moved northward on the 13th. At 0000 on the 26th, this 970-mb LOW was at 46.5°N, 26.0°W. The ALSTER EXPRESS reported 50-kt winds and 26-ft swells at 42.0°N, 33.5°W. Twenty-four hours later, the LOW, now at 966 mb, was 400 mi due west of Brest. Ocean Station Vessel "K" had been battling 45- to 50-kt winds, and up to 16-ft seas and 30-ft swells. Cape St. Vincent, Portugal, reported 60-kt southwesterly winds. As the LOW moved toward Lands End and the Irish Sea, it was filling but had lost none of its punch. Ocean Station Vessel "K" was still recording 45-kt gales and the seas had risen to 46 ft. Nearby, a ship reported 55-kt winds, but no wave heights. On the 29th, the storm stalled over the English Channel and a new LOW formed on the associated front near Sardinia, in the Mediterranean Sea. Within a few hours this new LOW dominated and drifted in the vicinity of Sardinia for several days.

Casualties--The 12,638-ton tanker AMOCO LOUISIANA inbound to Texas City, was in a collision with the 16,683-ton Norwegian bulk carrier FOSSANGER, in heavy fog. Both vessels experienced bow damage, but no injuries. The 20,889-ton British tanker VITTA ran aground in heavy fog in the New York East River. The 3,385-ton British motor vessel SUSAN CONSTANT bound for Stephenville, reported drifting with ice in the Straits of Belle Isle on the 11th. The icebreaker MANCHESTER CRUSADER escorted her to open water on the 12th. The 550-ton Swedish motor vessel NOVA and the 15,929-ton Greek motor vessel THEOFANO LIVANOS collided in fog off southern Sweden. The NOVA sank, but the crew was saved. THEOFANO LIVANOS sustained one dead and leakage in one ballast tank. The SAN ROBERTO, 7,863-ton Panamanian motor vessel, arrived at St. Michaels Inlet on the 16th, with weather damage. Ice in the St. Lawrence Seaway fractured portside shell plating and buckled a bulkhead on the 14,766-ton Liberian motor vessel HELENE. The 3.035-ton Liberian motor vessel ILKON TAK arrived at Jacksonville from Antwerp on the 26th, with heavy weather damage, cracked forepeak, and no fresh water.

ROUGH LOG, JANUARY 1973--The Icelandic Low was the dominant feature in the North Atlantic for the month of January. The number of cyclones were near normal and concentrated in the western sector, although the majority were farther to the east along the U.S. East Coast than in December. As the storms moved northward and eastward, they curved more northerly and concentrated in the Denmark Strait. It was strictly a dead end for the cyclones that entered the Davis Strait. One cyclone originated in the Gulf of Mexico and 10 days later ended off the boot of Italy. Approximately every 5 days a high-pressure area moved out of the Canadian plains, across the eastern United States, and into the central North Atlantic. No major storm centers tracked into the European land mass, except the one mentioned above which moved through Spain. Their associated frontal systems did penetrate as far south as the Mediterranean Sea, at times.

The mean pressure systems closely resembled climatology, except for minor differences in shape and major differences in values. The Icelandic Low was almost exactly at its mean position near Kap Farvel at 985 mb. The configuration was nearly circular without the usual trough east-northeastward across Iceland. This was the result of an abnormal High just north of the Black Sea. The Azores High at 1025-mb averaged 3-mb higher than normal. Pressures in the eastern United States averaged near normal. The higher pressures in the east-central North Atlantic, plus the high center over the Ukraine, accounted for the concentration of storm tracks in the Denmark Strait and a cyclonic, rather than zonal, wind flow in the northern Atlantic.

From the discussion above the major anomalies would not be hard to locate. The 985-mb pressure of the Icelandic Low verses a 997-mb normal, produced a negative 14-mb anomaly slightly to the east of the pressure center. Two positive anomaly centers, of 11 and 10 mb, were located near Oslo, Norway, and Moskva. A positive 2-mb departure occurred between 20° and 30°N from 55°W, eastward. A positive 5-mb maximum was centered near the Atlas Mountains. Again, as last month, the pressure gradients in the Northern North Atlantic were greater than the climatological mean.

No tropical cyclones have been detected in January according to records as far back as 1886. None occurred this month.

The first major storm of the month germinated as a 1018-mb LOW on a front east of Jacksonville, Fla., near 31°N, 79°W early on the 4th. Caught in the upper air flow the LOW sped up the East Coast at 35 kt and was off Cape Cod 24 hr later with a pressure of 997 mb. At 0000 on the 6th, the 982-mb LOW was over Stephenville, Newfoundland, and the USCGC DUANE, at 44.8°N, 59.7°W, was treated to 45-kt gales. Twelve hours later, the LOW halted abruptly as it came into alignment with the upper air LOW.

Late on the 6th, another wave with a 985-mb center, formed on the front near 41°N, 49°W. This new LOW moved northeastward and then north to a small center near Kap Farvel. During the next 48 hr, a series of LOWS developed southeast of the original LOW and moved counterclockwise around it to the vicinity of Kap Farvel, as the parent LOW remained quasi-stationary over Newfoundland. A strong band of winds developed about 600 mi south of the LOWS and the following ships reported the indicated winds and waves: HAMBURG, 55 kt and 33-ft swells; KRPAN, 50 kt; LEANNA, 60 kt; TACOMA CITY, 50 kt; USCGC CHAUTAUQUA, 45 kt and 25-ft swells; and the USCGC WINNEBAGO, 45 kt.

On the 9th, the various LOWS combined into a deep 956-mb single LOW, near 59°N, 49°W. During this consolidation, the gradient loosened slightly and the maximum winds reported were 45 kt. The LOW now started filling and drifting up the Davis Strait where it wandered around the Labrador Sea until the 15th.

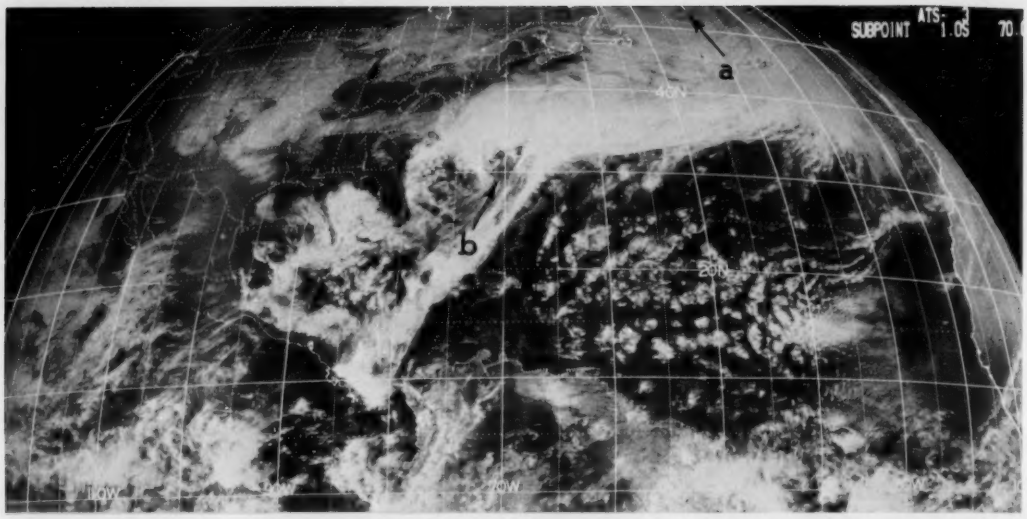

Figure 34.--ATS-3, 1600 January 13, 1973--two violent storms that generated hurricane-force winds are shown in this photograph. Arrow "a" points to the center of the first LOW, at the top of the picture near 55°N, 40°W. Arrow "b" indicates the center of the second LOW, near 41°N, 70°W. Both storms resulted in ship casualties.

It was then reinforced by another LOW moving in from the south and moved northward into the Baffin Sea. A small center split off with the frontal system and moved into the Denmark Strait.

On the 10th and 11th, a trough of low pressure was analyzed south from Hudson Bay. By 0000 on the 12th, a 998-mb LOW had incubated and moved to near Sept Isles, Quebec. The LOW continued eastward and by 0000 on the 13th, was off Newfoundland near 51°N, 47°W, having been reinforced by another LOW moving northeastward off the Atlantic coast. Gale winds were occurri ig in the southwest and southeast quadrants, and Ocean Station Vessel "D" was caught by 55-kt storm winds as the occluded front passed its location.

Twelve hours later, this extratropical cyclone made like a hurricane (fig. 34). The pressure plunged to 950 mb. Two ships were tossed by hurricane-force winds. The JUDITH SCHULTE (46.7°N, 36.8°W) encountered 70-kt winds with no report on seas, and the INISHOWEN HEAD (48.2°N, 40.2°W) had 65-kt winds and 43-ft swells, 540 and 420 mi, respectively, to the south of the center. Ocean Station Vessel "D" was still being rocked by 55-kt westerlies and 23-ft waves. The AMERICAN ACE was bucking 50-kt gales, and the TYMN, a raging 60 kt, near the occluded front. The MONT LAURIER reported that trailers broke adrift at 2020 on the 13th, about 500 mi northwest of the Azores. The vessel requested assistance, and 3 hr later, a fire broke out. At 1400 on the 14th, the crew was reported abandoning the vessel. Sixteen were picked up by the LIVERPOOL BAY and the PENERF. The rest remained aboard. The storm continued moving northerly and reached a minimum pressure of 936 mb near 57°N, 36°W, on the 14th. At that time, winds greater than 50 kt were found in all quadrants. The DART AMERICA just northeast of Ocean Station Vessel "D" (50-kt winds) was pounded by a stormy 55-kt, 26-ft seas, and 41-ft swells. Ocean Station Vessel "J" hosted 50-kt gales, and the USCGC MUNROE and the VASSIJAURE, many miles apart on opposite sides of the LOW, encountered 55-kt winds. On the 14th and 15th, strong winds at Bilboa, Spain, broke the mooring lines of the CABO PENAS, which struck the ALEXANDER HAMILTON, which, in turn, struck the EL GAVILAN. The storm was now losing its energy and stalled near Kap Mosting. It blew its last breath on the 17th.

Monster of the Month--To catch the beginning of the next storm, we go back a week and to the Gulf of Mexico. On the 10th, a 1011-mb LOW formed in the middle of the Gulf. The LOW deepened slowly, and just as slowly, moved to the east. At 1200 on the 13th (fig. 34), the center was down to 996 mb and located near 30.5°N, 71.0°W. The FORT DE FRANCE, about 200 mi to the southwest, was engulfed by continuous moderate rain, driven by 50-kt winds. As the storm came under the influence of the upper air circulation, its speed increased. At 1200 on the 14th, it was located 650 mi due south of Newfoundland. The ATLANTIC FOREST, 280 mi south-southwest of the center, was proceeding south with a 50-kt westerly wind and 33-ft swells from 250°.

During the next 24 hr, the LOW took an easterly track and at the end of that time was midway between Newfoundland and Portugal. It was a relatively small but intense storm. The ZEBEDIELA was struggling against 60-kt storm winds about 100 mi southeast of the center. The FRUBEL PRINS PALA, PERT HILVERSUM, and Ocean Station Vessel "E" all were visited by winds of 50 kt or greater as they came in contact with the storm.

As the storm continued to roll across the top of

the Azores High, the CHERTAL and the DISCOVERER found 50-kt blowing on the opposite sides of the LOW. About 1000 on the 16th, the LOW at 965 mb passed south of Ocean Station Vessel "K," headed for Cabo Finisterre. The LOW had lost none of its power, and the KARUKERA combated 60-kt winds and 46-ft swells, 370 mi to the southwest. Three other ships, south thru west of the center, contended with 50- and 55-kt winds and waves up to 33 ft. They were the KRASNOKAMSK, STAR ASSYRIA, and the VASSILII SOURIKOV. The ADRIATIC SEA was forced aground near Casablanca by the violent storm. The NAVI TRADER, Rotterdam for Florida, sustained machinery damage and reported leaking,100 mi north of the Azores. At Ponta Delgada on the 17th, she reported that three main engine lubricating oil tanks had fallen on the floor plates due to heavy weather and caused the death of the Chief Engineer and one fireman.

The LOW passed over Spain on the 17th, bringing rain on the plain. It lost much of its power over land as it appeared to lose its energy source. At 0000 on the 18th, north of the Balearic Islands, the pressure had jumped to 1001 mb. It continued to drift across the Mediterranean Sea and deteriorate until the 20th when it lost its identity completely.

This was one of those storms that could possibly go undetected for some time, if it were not for your valuable ship reports. The first indication of something in the wind was a report of moderate continuous rain by the AFRICAN COMET on the 0000 chart of the 19th. Twelve hours later, reports from the CRYSTAL DIAMOND, EUROPA, IRISH STAR, KRASNOURLSK, and MEDON, located the position of a newly formed 1004-mb near 29°N, 70°W (figs. 35-36).

At times, it may seem that the important observations are those of high winds and seas because they get the attention, but these reports were even more important because they identified a new storm that could be a threat, when no other source was available to indicate cyclogenesis.

By 0000 on the 20th, the LOW, now 992 mb, was moving northward and Bermuda had 30-kt winds. Farther east, the MATHIESON was being washed by rain, driven by 50-kt winds. It wasn't long until many other ships were aware of the storm's existence as it approached the major shipping lanes. At 1200 on the 20th, the BUNTENTOR, about 200 mi south, and the NORMANNIA, 50 mi east of the center, which was near 38.5°N, 62.0°W, were battered by 50-kt winds and precipitation of various types. The 960-mb LOW

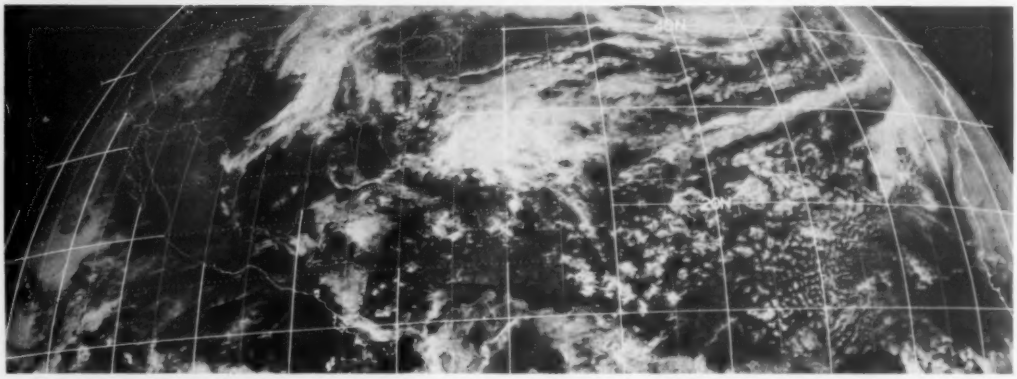

Figure 35. --This satellite picture of 1600 on the 18th indicates only a wide area of clouds, south of Bermuda, with no apparent organization. The report from the AFRICAN COMET, at 0000 on the 19th, indicated the possibility of cyclogenesis.

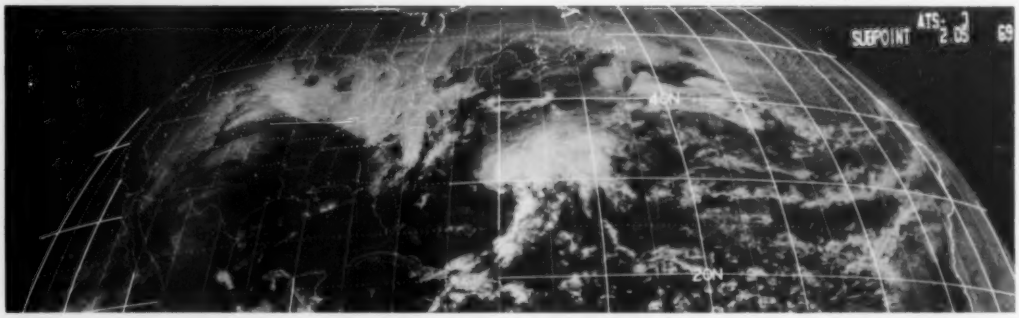

Figure 36. --Twenty-four hours after figure 35, an area of cyclogenesis is indicated near 30°N, 69°W, as the cloud pattern indicates the formation of a cyclonic circulation.

passed northward over Newfoundland. A sharp trough was left behind in which another LOW formed. At about 0600 on the 22d, the New Bedford fishing vessel THE NINE lost power in 60-kt winds and 20-ft seas, 70 mi off Cape Cod. Two Coast Guard helicopters rescued the crew members, but the ship sank prior to the arrival of the USCGC TAMOROA with pumping equipment. Troughing reduced the wind speeds in most areas, though many ships reported 35- to 45-kt gales as far south as 34°N. Ocean Station Vessel "D," received a 50-kt buffeting prior to frontal passage. By 0000 on the 22d, the 952-mb LOW combined with the semipermanent LOW near Kap Farvel.

The remainder of the month was relatively quiet, for the North Atlantic in January. No major low pressure area was dominant. Small LOWS developed and dissipated as they raced along that southwest to northeast freeway toward Iceland. Many gale-force and isolated storm-force winds were logged and plotted, as individual LOWS transited the area.

Casualties--It was the time of the year for ice damage, especially in the St. Lawrence Seaway. On the 1st, the 16,471-ton Norwegian bulk carrier ORION ran aground in ice near Sorel, Quebec, and on the 2d, the 4,491-ton Canadian tanker MAPLEBRANCH was aground in heavy ice at Rimouski Entrance. The Greek ARISTOFANIS, a 10,503-ton carrier, arrived at Sorel with ice damage to the no. 5 hold. The Canadian FORT LAUZON, a 988-ton cargo carrier, was ice-bound in the Straits of Belle Isle on the 13th. The 6.033-ton Greek motor vessel YANNIS put into St. Johns, Newfoundland, due to leaks after contact with ice.

The Liberian-registered STOLT CATALINA arrived at Ponta Delgada, Azores on the 2d with weather damage. The 26,650-ton Liberian tanker NAESS MARINER collided with a tow of barges, on the Mississippi, upriver from New Orleans. Fourteen barges broke away, and the ship received a 5-ft gash below the waterline.

Rough Log, North Pacific Weather

December 1972 and January 1973

ROUGH LOG, DECEMBER 1972--Cyclone activity in the North Pacific was slightly higher than usual. The storm track out of Manchuria into the Bering Sea was near normal, although nearer the western shore. The significant difference from climatic records was the primary track from south of Honshu. It is northeastward into the Aleutian Islands, normally, but this month it was almost due east between 35° and 40°N, to near 155°W, where cyclones either dissipated or turned northeastward toward the coast of British Columbia.

Climatologically, during December the Aleutian Low is elongated east-west with the main center of 1001 mb in the western part near 52°N, 162°E. A 1034-mb High is located over central Siberia and a 1021-mb narrow High extends from northern California southwestward toward the Hawaiian Islands. During December 1972, the pressures all across the North Pacific were generally higher than normal, but some of the pressure centers were displaced resulting in several large anomalies. The mean Aleutian Low averaged about 3 mb higher than normal with four separate centers. The one near the Kamchatka Peninsula was near its normal position, another was south of Dutch Harbor, and another was in the Gulf of Alaska. The most significant Low was near 40°N, 158°W. The Highs over Siberia and off the California coast were 2 or more mb higher than the normal, as was the pressure across the central North Pacific along 30°N.

There were two major negative anomalies. The most important and largest was 11 mb, centered near 37°N, 156°W. The other negative anomaly of 4 mb was about 250 mi southwest of Vancouver Island. In addition, there were two positive anomalies located near 45°N, 160°E and near 60°N, 170°W in the Bering Sea. There were several positive 3- to 5-mb anomaly centers south of 30°N.

No tropical storms occurred in the eastern North Pacific, and none have been detected later than November since satellite coverage began in 1966. Two typhoons, Sally and Therese, and one tropical storm, Violet, occurred during the month. Normally about one tropical storm a year is expected, and three out of four of these develop to typhoon strength.

The first storm of this month formed in central China and for the first days of its existence gave little indication of developing into anything. As the LOW passed up the Sea of Japan on the 1st, it split into two centers astride Hokkaido. The new LOW became the predominant one and, at 1200 on the 1st, was near 44°N, 145°E. To the south of the LOW, the KASHU, SHOZUI MARU, and WAKO MARU were buffeted by 40-kt gales. This LOW split again on the 2d, with the HAKONE MARU, ST. LAWRENCE MARU, and the TOCHIGI MARU to the south and west of the center on the receiving end of 50-kt gales. The EREC, a Russian weather ship, also reported 50-kt winds. One crew woman was killed and 12 other crew members were missing as 18 fishing boats sank and 133 others were damaged off Bekkai, Hokkaido. Six houses were destroyed and 114 flooded as 20-ft waves swept low-lying sections. Two other fishing boats were missing near Etorofu, Kuril Islands, where winds of 58 kt were reported.

By the 4th, the LOW had reached 51°N, 170°E, at a pressure of 966 mb. The ORIENTAL JADE was boosted along her track with a 50-kt stern wind. A high-pressure area in the Gulf of Alaska was moving very slowly to the southeast resulting in a tight pressure gradient ahead of the LOW. Many ships were experiencing gale winds of 35 to 40 kt. On the 5th, the KOTOKU MARU, near 52°N, 165°W, reported 45-kt gales while the storm had moved into the Bering Sea. By the 6th, the LOW had filled to 979-mb and moved ashore near Mys Olyutorskiy. The cold land area, plus a low pressure area in the Arctic Sea, ended this storm's career.

The previously mentioned high-pressure area in the Gulf of Alaska retreated northward into the Yukon to

join with an already existing HIGH to form a 1055-mb pressure dome. At this time, on the 5th, a 1011-mb LOW suddenly developed in a col area off Seattle. The VANCOUVER, 300 mi off Cape Flattery, reported 40-kt gales. Early on the 6th, the LOW, now at 997 mb, had moved southwest of Portland. Off the northern tip of Vancouver Island, the UNYO MARU was buffeted by 55-kt winds. The NNCR reported heavy continuous snow blown by a 45-kt gale. Winds up to 48 kt roared through Portland, Oreg., and gale warnings for 45 kt were posted along the coast with 60 kt in the mountains. The LOW now down to 1000-mb pressure, passed onshore in southern Oregon at 0600 on the 6th. The WASHINGTON MAIL reported 45-kt gales about 300 mi out of Seattle. On the 7th, the LOW was well into Nevada, but gale-force winds remained off the coast as the AMERICAN LEGION and STEEL APPRENTICE could attest. The storm stalled in the Great Basin after leaving much welcomed moisture all along the west coast.

One of several storms that formed and dissipated in that area of large negative anomalies north of Hawaii, had its beginning on the 4th near 29°N, 150°W. It wandered in the area, in a clockwise loop, at about 1000-mb pressure until the 7th, without effecting shipping. At that time, the MONTEREY and Ocean Station Vessel "N" reported 40- and 45-kt gales. "N" also reported 16-ft seas and 26-ft swells. Twenty-four hours later, the LUNA MAERSK had 40-kt gales in the same area. The LOW was now intensifying and, at 1200 on the 10th, the pressure had dropped to 988 mb. As the area of circulation expanded, more ships became involved. The following ships reported 35- to 50-kt winds with seas to 25-ft: the BELLNES, CHICAGO, KOREAN TRADER, MARCHEN, and the MARGARET CORD. Again the storm made a loop during the period of the 10th to the 12th, but this time counterclockwise. On the 12th, as the LOW was near 32°N, 155°W, a ship, 180 mi to the south, was hit by 45-kt gales. Now, the LOW was filling and moving northeastward as a wave on a frontal system approached from the west. By 0000 on the 14th, this new system had absorbed the old one and continued into the Gulf of Alaska.

Compared to most of the individual systems this month, this LOW had a long life. The lineage starts with a frontal system that came out of Manchuria and China on the 7th. The front moved eastward with a steady pace and, on the 10th, a wave formed near 36°N, 166°E. The possibility of its surviving seemed remote, as it was sandwiched between a high and a ridge. Survive it did, as it was well identified by ship reports. On the 12th, the ridge had retreated northward as the LOW had intensified to 1004-mb and had taken a southeasterly course toward the active cyclone area for this month, which was located between Alaska and the Hawaiian Islands. It was on the 14th that it absorbed the previously described system. By the 15th, the LOW was at 38.5°N, 145.0°W and the HAWAIIAN MONARCH, TERUKAWA MARU, and the USCGC WACHUSETT all reported 40-kt gales in the southern quadrant of the storm. The LOW picked up speed in its northeasterly movement. The BARON-FORBES, HAWAIIAN CITIZEN, and the WORLD PRESIDENT reported 40- to 50-kt winds along the front and south of the LOW. The WORLD PRESIDENT was being washed by heavy continuous rain.

At 1200 on the 16th, this LOW combined with a stationary 970-mb LOW just south of Valdez. The OREGON MAIL was proceeding toward Ocean Station Vessel "P" with 50-kt gales.

Between 0000 and 1200 on the 21st, a well-defined small 986-mb LOW developed near 45°N, 135°W, as a wave raced up the front in the area. The TAI SHOU, very near the center, suddenly found 50-kt winds off her bow. The LOW raced toward the Olympic National Park on the 22d, and the HAWAIIAN, 350 mi southwest of Astoria, was rolled by a 45-kt crosswind. By 0000 on the 23d, the LOW was well into the State of Washington.

A cold front extended south, then southwest out of a LOW moving along the Aleutian Islands. Near 34°N, 149°E, on the 20th, a wave formed with 1003-mb pressure. Twenty-four hours later, the now 992-mb LOW had sped 1,000 mi to 40°N, 169°E. Along the way, several ships reported gale winds and others must have experienced them during nonsynoptic hours. Apparently caught up under or with the jet stream, the LOW continued its headlong plunge eastward to 43°N, 161°W, at 0000 on the 22d. The central pressure was now 980 mb. Along the way, the AMERICAN AQUARIUS and the ORE MERIDIAN encountered 45- and 40-kt gales, respectively. At this time, the LOW curved northeastward into the Gulf of Alaska and braked to a near halt. The pressure was now 952 mb, near 52°N, 151°W at 0000 on the 23d. Gale winds of up to 50 kt were being reported in all quadrants. These included the GOLDEN ARROW, MATSUBARA MARU, and the JAPAN AZALEA. In the next 24 hr, the DAISHOWA MARU and Ocean Station Vessel "P"

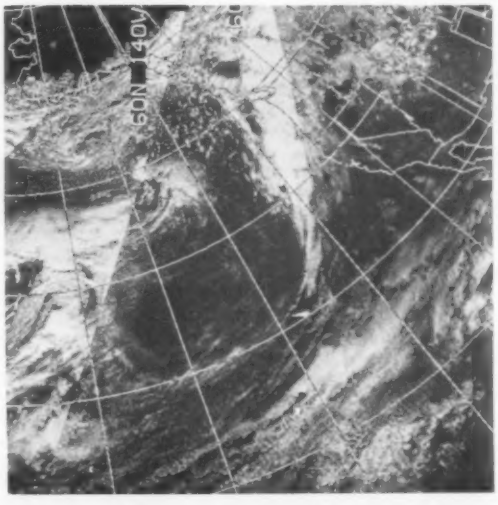

Figure 37.--A composite satellite picture on the 24th shows the weather systems present when the PACROVER sank and the 48-ft crab boat was overturned by huge swells. Two LOWS are in the Gulf of Alaska. The LOW that produced the disastrous winds and seas for the PACROVER is located near 50°N, 147°W. The front is approaching the U.S. West Coast and the crab boat.

were pounded by gales up to 50 kt. As the LOW moved slowly northward off Kodiak Island, another LOW moved in from the southwest and assimilated it in its circulation early on the 25th. The 12,723-ton carrier PACROVER, with 33 crew members, radioed it was sinking 750 mi south of Kodiak Island on the 24th. Search and rescue vessels and aircraft found no survivors, but did find an oil slick and overturned lifeboats. One report said the ship radioed it was sinking in 55-ft seas and 50-kt winds. A Coast Guard aircraft reported 20-ft waves and 50-kt winds. This would have been south of the LOW, moving in from the southwest. Also on the 24th (fig. 37), a 48-ft crab boat was overturned three times by huge swells off the northern California coast. Four men aboard were rescued. The TOKUSHIMA MARU reported 60-kt southeasterly winds ahead of the front near Vancouver Island. South and east of the LOW, now near 55°N, 147°W, all reports were greater than 35 kt for a radius of 600 mi. By the 27th, only a trough remained in the area.

This weather system tracked from the South China Sea to the Gulf of Alaska. A low-pressure area, 1010-mb, moved out of China and, at 1200 on the 22d, was near 28°N, 125°E. Heavy rain was reported north of the warm front at that time. As the LOW gained strength and moved to the northeast up the coast of Japan, the SHOHUKU MARU was buffeted by 40-kt gales. At 0600 on the 24th, the 998-mb LOW was off Tokyo Bay, while the front had raced hundreds of miles ahead. Over 5,000 homes were flooded east of Tokyo as the storm dropped over 8 in. of rain. Many rainfall records were broken. In the mountains west of Tokyo up to 16 in. of snow fell. The 6,516-ton Liberian freighter VINCEVERETT sprang a leak which flooded its engineroom .

In the next 48 hr, the system continued deepening and the winds picked up, especially in the southern half of the circulation. The EVER LIGHT, at 35°N, 154°E, about 350 mi southwest of the center, was bucking a 50-kt headwind and waves of 20 ft. Closer in, the KINKO MARU and the NANSHO MARU reported 40-kt gales.

By 0000 on the 27th, the LOW had arrived at 46°N, 177°W, with a pressure of 960 mb. The JDXW was sailing along with 50-kt winds and 30-ft swells off her stern, 12 hr earlier. At this time, the JUZAN MARU, 450 mi to the south, was riding out 55-kt storm winds and 33-ft swells from the stern. In addition, these vessels encountered 45-kt gales to the north, southwest, and southeast of the LOW center: the HARUNA MARU, NANSHO MARU, and the SHOKAI MARU (heavy snow). For the next 24 hr, the storm continued its northeasterly track south of the Aleutian Islands. Gale-force winds were reported in all directions as far as 600 mi from the center. At 1200 on the 28th, the CALIFORNIA, north of Atka Island, was rolled by a 45-kt crosswind with 16-ft seas and 26-ft swells quartering off the stern. To add to the misery, the temperature was -1°C with rain and snow showers. The wind speeds started dropping considerably as the central pressure increased from the minimum of 954 mb at 1200 on the 27th. A few reports of minimal gale-force winds continued to be received as the LOW moved toward Prince William Sound, which became its burial ground late on the 31st.

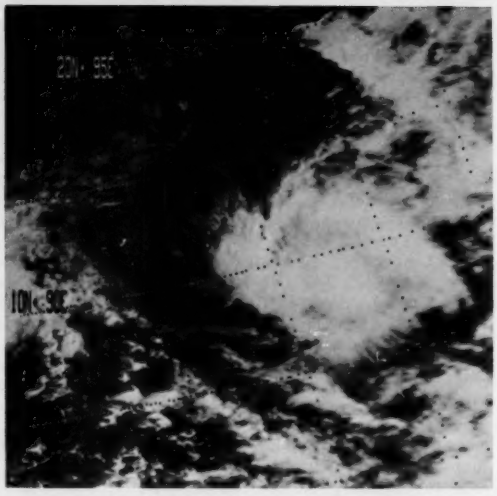

Figure 38.--Typhoon Sally, at 0300 on the 3d, made history by churning through the Gulf of Siam.

Sally was detected as a tropical storm on the 1st, some 200 mi southeast of southern South Vietnam. She reached typhoon strength that same day, and moved west-northwestward into the Gulf of Siam (fig. 38). The JAPAN ORCHID and the MADISON LLOYD both reported 35-kt gales well to the northeast of the storm. By the 3d, she was generating 75-kt winds. Sally was the first typhoon in the Gulf of Siam since accurate records started in 1945. The typhoon lost strength as she moved across the Gulf and was reduced to tropical storm strength on the 4th near the Isthmus of Kra (10°N). Here she crossed the Malay Peninsula and moved into the Andaman Sea. Sally was now considered a tropical cyclone of the Indian Ocean. On the 7th and 8th, she moved northward along the 95th meridian. Near the mouths of the Irrawady, Sally turned eastward and crossed the coast of Burma on the 10th.

Late season typhoons usually form south of 15°N and often cause trouble in the central and southern Philippines. Typhoon Therese was no exception. Therese was initially found on the 1st about 180 mi east of Koror, as a tropical depression. The next day, she moved across that Island as a tropical storm. Koror recorded a maximum wind speed of 43 kt on the 2d. Her track was a typical west-northwesterly one and the Philippines lay ahead. Therese became a typhoon off the coast of Mindanao on the 3d, and the MICHIJU MARU found 35-kt gales 500 mi to the north. It took her 1 day to make it across the Central Islands and, on the 4th, Therese, a tropical storm again, made it into the South China Sea. She stalled north of Palawan until the 6th, when once again she reached typhoon strength. Shipping seemed to give her a wide berth as the highest winds reported by ships were 30 kt 100 to 200 mi from her eye. The typhoon moved west-northwestward toward South Vietnam. Winds near the

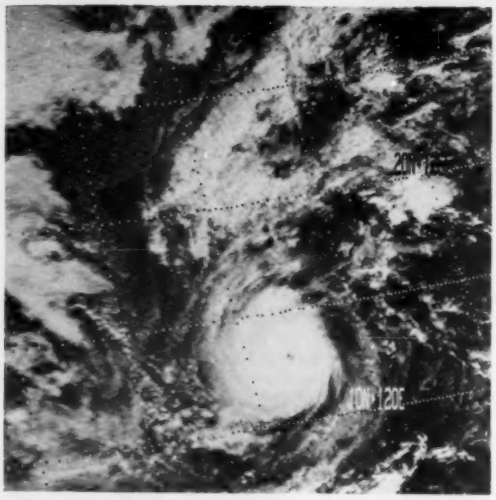

Figure 39.--Typhoon Therese displays a well-defined eye on the 7th, in contrast with typhoon Sally shown in figure 38.

center reached 105 kt with gusts to 145 kt on the 7th (fig. 39). As Therese approached land, she began to weaken. On the 10th, the typhoon, generating 75-kt winds, moved across the South Vietnam coast south of Da Nang.

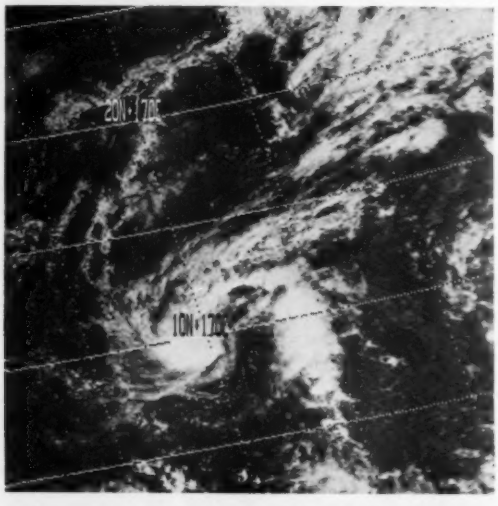

Figure 40.--This NOAA-2 satellite picture of tropical storm Violet on the 13th does not show the torrential rains that she dumped on Majuro Island of the Marshall Islands.

As Therese withered in South Vietnam, Violet bloomed briefly across the sea among the Marshall Islands. Violet was not a violent storm as judged by wind intensity; maximum winds reached just 45 kt on the 14th and 15th. Rains were torrential. On the 12th and 13th (fig. 40), she dumped 17.88 in. on Majuro, as she moved past the atoll on a northwesterly course. Majuro also recorded a maximum wind of 30 kt on the 12th. Violet turned into a tropical storm on the 13th, and reached almost 10°N before reversing her field toward the southwest. She then brushed Kwajalein with 29-kt winds on the 17th. But here again, rain was the real culprit. A new 24-hr amount of 17.15 in. fell on the 16th and 17th on the atoll. After this, Violet slowly faded during the next 2 days.

Casualties--The 5,888-ton Pakistanian motor vessel RANGAMATI reported heavy weather damage at Singapore, as did the Cunard CARAVEL after docking at Chiba. The debris from a missing 32-ft cabin cruiser was found in the Gulf of California on San Jose Island on the 5th.

ROUGH LOG, JANUARY 1973--This month the climatological Aleutian Low, at 1000.4 mb, was located at 50°N, 165°E. This is about 350 mi east of the southern tip of the Kamchatka Peninsula. A 1021.3-mb HIGH was centered about 700 mi southwest of San Francisco. The mean Aleutian Low for this month was shaped like a wide letter "U," with two main centers. One, near the climatological position 1002 mb, the other at 1001 mb, was in the Gulf of Alaska. The Pacific High center off the California coast was slightly south of its climatic position at 1022 mb. The major anomaly centers included a negative 10 mb near 45°N, 142°W; a negative 9 mb near 57°N, 141°W; and a positive 10 mb in the Sea of Okhotsk. The pressure across the central North Pacific from Japan to Baja California averaged about 4 mb higher than the climatic mean. Of interest, even though it did not appear to directly effect the North Pacific weather patterns and storm tracks, was a negative 16-mb anomaly over the Arctic Ocean in the vicinity of 80°N.

The primary storm tracks followed the climatological pattern from the Sea of Japan and the East China Sea into the Barents Sea and the Gulf of Alaska. The significant departure was a secondary track across the central North Pacific from the East China Sea to the Gulf of Alaska and above-normal activity from the central Pacific into the Gulf of Alaska. The cyclone tracks in general were more easterly than normal. This was indicated by the anomalies.

No tropical cyclones formed in the North Pacific this month in either the eastern or western areas. None are expected in the east, but one every 2 yr is average for the western Pacific with half of these reaching typhoon intensity. Those that occur normally germinate in the vicinity of 10°N, 135°E.

The North Pacific lived up to its name this month, in comparison with the Atlantic, although those ships caught in high winds and waves will probably disagree.

On the 1st, a double 1010-mb LOW developed in a col area south of Japan near 25°N, 130°E and 34°N, 134°E. The southernmost LOW contained a frontal wave. By midday on the 2d, the two LOWS moved northeastward with one at 985 mb near 39°N, 145°E and the other at 982 mb near 46.5°N, 145.5°E. Ahead of the front, at 34°N, 153°E, the CHOKAI MARU

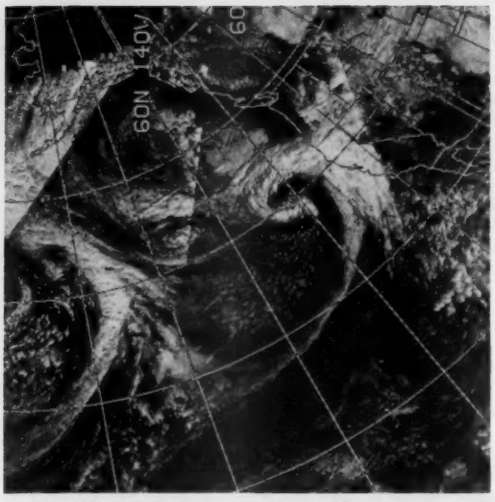

Figure 41. --Three of the five LOWS that stretched across the North Pacific late on the 9th, from the coast of California to Honshu, Japan, are shown in this composite picture. From east to west, they are near: 41°N, 130°W; 42°N, 147°W; 44°N, 168°W.

was lashed by 45-kt gales. Early on the 3d, the southern LOW could no longer be located with the data available, but at 1200 two LOWS could again be analysed--one on each side of the Kamchatka Peninsula. At that time, the weather station on Ostrov Paramushir was buffeted by 50-kt winds. The GYOKUYO MARU at 50°N, 160°E, experienced 45-kt gales, and the CANADA MARU, HARUKAWA MARU, and KASUGAI MARU all reported 40-kt gales. Twelve hours later, the GYOKUYO MARU was still in the 45-kt wind band and the CHICHIBU MARU at 50.4°N, 162.5°E, at 1200 on the 4th was hit by 50-kt winds. As the LOW continued northeastward along the shore of the Barents Sea, the central pressure started to rise. As the KHINGAN reported 45-kt gales on the 5th, the pressure was 978 mb. For the next 2 days, it continued drifting toward the Bering Strait and early on the 7th disappeared from the charts.

On the 6th, a wide area of low pressure, with several centers, dominated the weather chart. At 0000 on the 7th, a new LOW was found to have developed near 40.0°N, 176.5°E at 997 mb. Late on the 9th, two separate LOW centers developed (fig. 41). There were now five LOWS roughly along 43°N between California and Japan. Several ships reported minimum gale-force winds. On the 10th, the LOW again combined into one large circulation. The JHHE was splashed by 50-kt winds as was the PHILIPPINE BEAR in the same general area near 35°N, 150°W.

For some unknown reason, the ship data in the vicinity of this storm were very sparse. With the pressure gradients involved, it is very likely that higher winds and more ships were involved. At 1200 on the 11th, the LOW center passed east of Ocean Station Vessel "P," which reported only 20-kt breezes. The LOW idled in the Gulf of Alaska and disappeared on the 15th.

A new 1015-mb LOW was born 200 mi south of Kyushu at 1200 on the 14th. As it proceeded northeastward and eastward off Japan, its circulation developed and 36 hr later the pressure was 997 mb near 33°N, 148°E. The LOW continued moving eastward and at 0000 on the 17th was near 34.5°N, 167.0°E at 990 mb. During this period, several ships encountered winds of 35 kt as the storm passed in their vicinity. Early on the 17th, the STAR ACADIA, 320 mi west of the center, was buffeted by 45-kt winds and 20-ft seas. The JUJO MARU No. 2 and the LONG BEACH MARU both reported 40-kt gales, north and southeast of the storm, respectively.

On the 17th, the LOW took an abrupt turn toward the northeast and started assimilating a low-pressure area located off the Kamchatka Peninsula. This also triggered a rapid deepening and by 1200 on the 18th, the pressure had dropped to 946 mb--its lowest. At that time, the GEORGIANA, near 43.9°N, 179.9°E, was hammered by thunderstorms, 60-kt winds, 26-ft seas, and 30-ft swells. The center was located at 48°N, 178°W. The GEORGIANA, traveling in the same direction and at the same speed as the LOW, remained about 200 mi south of the center for the next 36 hr. The wind speed gradually decreased to 40 kt, but on the 19th she reported 39-ft seas and 26-ft swells. Ships in all quadrants were reporting 35- to 45-kt winds, as far as 600 mi from the center.

This younger brother of the previous storm was incubated in the same area south of Kyushu on the 17th. It very nearly qualified as the Monster of the Month. The LOW tracked along the southern and eastern shore of Japan on the 17th and 18th, drenching most of the islands in rain. By 0000 on the 19th, the central pressure was 980 mb near 37.5°N, 151.2°E. The BELNOR, 150 mi south of the center, was battered by the storm which was now 50 kt. The KAWAGAWA MARU, ORIENTAL JADE, and TAIKAI MARU, east, southeast, and northwest of the center, respectively, struggled with 45-kt gales. The STAR ACADIA, after a respite from the preceding storm, continued westward and received 45-kt gales with 25-ft seas and 30-ft swells from this one, on the 19th.

At 0000 on the 20th, the LOW was at 39.6°N, 170.0°E with a 972-mb pressure. The JKCO, 250 mi to the north, was battered by 70-kt hurricane-force winds. Thirty-five- to 45-kt winds were common in all directions. Late on the 20th, this LOW absorbed the previous LOW in its circulation. As the combined LOW moved east-northeastward, it was near 41.5°N, 170.0°W at 963 mb at 0000 on the 21st. The strong wind band appeared to have moved counterclockwise around the LOW, and the EDELWEISS reported being hammered by 70-kt cyclonic winds near 39.5°N, 178.5°W or about 375 mi west of the center. The GEORGIANA again took a pounding as she reported 50- and 55-kt winds for the next 24 hr as the storm caught up with and passed her position. At 1200 she also reported 43-ft swells from her starboard side. At 1200 on the 22d, the 956-mb LOW was just southeast of Cordova, Alaska, with a sharp trough to the south. This sharp trough plus the terrain of Alaska and the Yukon broke up the LOW into three small lows. Rapid disintegration now took place and was completed on the 23d.

The Polar Front lay in the area of 20° to 25°N in the

western North Pacific. At 0000 on the 22d, two waves formed on the front, but only one, near 25°N, 157°E, was vital. This wave was caught in the upper air circulation and at 0000 on the 24th was near 38°N, 175°W. The LOW was sandwiched between two rather large HIGHS and did not develop well at first, being only 1006 mb at that time. The meteorological system moved generally eastward and the LOW squeezed northward, gradually breaking the grip of the surrounding HIGHS. This was a slow process, but at 0000 on the 27th, the low center was near 47.6°N, 144.8°W. The central pressure was 976 mb. The KASUGAI MARU, at 45°N, 130°W, 630 mi to the east, ahead of the front, had a 50-kt southerly crosswind with 23-ft swells from the southeast. The TAIKAI MARU was now west of the LOW with 50-kt gales, which had switched from southerly to northwesterly during the day as the low passed south of her position. Although the LOW conquered the HIGH to the east, the battle had caused considerable aging. At 1200 on the 28th, the pressure had risen to 992 mb. Twelve hours later, two centers developed which furthered the weakening and, on the 30th, only a trough remained off the California coast.

We return now to the East China Sea on the 23d. A weak low pressure area drifted out of mainland China and developed a 1010-mb center as it passed over the warmer water. The frontal system regenerated and the LOW passed over the Sea of Japan on the 24th. As the center passed over northern Honshu late on the 24th, the pressure had dropped to 994 mb. The ST. LAWRENCE MARU, 320 mi to the south and ahead of the cold front, was rained on and rolled by a 45-kt southerly crosswind. Farther to the north, the MARUSUMI MARU breezed into a 40-kt headwind at 15 kt.

A band of relatively high winds stretched across the top of the HIGH which separated this LOW from the previously described LOW. The KENSHO MARU, near 46.5°N, 171.0°W, cruised through the 50-kt isopleth, early on the 26th. At 0000 on the 27th, the LOW was at 52°N, 175°E, with a 980-mb pressure reading. The DAISHIN MARU was 60 mi south of the center when she was buffeted by 50-kt gales and 33-ft swells. Twelve hours later, the LOW split into two centers, and the original and most northerly one raced through the Barents Sea and across the Seward Peninsula on the 28th. The southerly LOW followed closely behind and late on the 29th disappeared over the north slope of Alaska.

During this last week of the month, the northern North Pacific was host to a wide variety of complex low systems which appeared to be generated more by local affects than the major meteorological circulation. At 1200 on the 29th, two small LOWS straddled the Kamchatka Peninsula, and an island station measured 50-kt winds. A small LOW developed south of Kodiak Island on the 29th. Another LOW quickly moved northeastward out of the central ocean on the 30th as the ARCO PRUDHOE BAY shivered with 50-kt winds of 1°C at 57°N, 145°W, just south of the LOW at 0000 on the 31st. The chart was crowded with reports of 40-kt gales all around both centers that day.

This storm barely made the January list. It appeared over Manchuria on the 31st. On February 1, it had tracked across Hokkaido and the Kuril Islands. At 0000 on the 2d it was making a name for itself as the barometer showed a 973-mb center near 47.5°N, 162.5°E. Forty-knot gales surrounded the center. Twelve hours later, the pressure had plummeted to 958 mb as it moved north to 55°N, 168°E. Forty- to 50-kt winds were still roaring around the center. For over 24 hr, the Komandorskiye Islands reported winds greater than 50 kt. At 0000 on the 3d, they measured 70 kt with a -7°C temperature. Gale winds extended 1,200 mi to the southwest. Most of the reports received were from island or shore stations. Any ships in the area must have been blown by winds of equal or greater strength. By the 4th, the LOW was filling rapidly and stalled near 60°N, 172°E. It disintegrated later that day.

Casualties--Happily, weather casualties were light for this month. The No. 8 DAIKO MARU, a 605-ton Japanese freighter, sank off Akita Prefecture in 35-kt winds and high seas. One crew member was listed as missing. The 14,250-ton Swedish motor vessel PARALLA arrived at Tacoma with heavy weather damage to cargo and mobile machinery.

Marine Weather Diary

NORTH ATLANTIC, MARCH

WEATHER. March is a transition month. The weather retains many of the wintry aspects of January and February and at the same time begins to exhibit some features typical of spring. During the first part of March, the weather is generally a continuation of winter conditions, gradually approaching springlike characteristics near the close of the month. However, wide variations from the climatic averages may be expected, and this pattern is not always the rule.

The Icelandic Low (1005 mb) rests southeast of Kap Farvel near 58°N, 40°W, while the Azores High contains two 1020-mb centers southwest of the Azores near 27.5°N, between 35°W and 42°W.

WINDS from westerly quadrants generally prevail over the major part of the western North Atlantic north of 30°N. Northerly or northeasterly winds blow more often over the waters between southern Greenland and western Iceland than any other winds from the four cardinal and four intercardinal points of the compass. Winds shift to a southerly component as one moves eastward from 35°W and to variable in direction over the Norwegian Sea east of 5°W. Near the coasts of Morocco and Portugal, northerly winds predominate. South of 30°N, the "northeast trades" are the dominant winds over most of the ocean with few exceptions. East of the Florida coast to about 68°W, wind directions are southeasterly to southerly. There is a strong tendency for easterly and south-

easterly winds over the Gulf of Mexico. Over the Mediterranean, westerly to northwesterly winds prevail. For the month as a whole, winds of force 4 to 6 prevail north of 40°N (north of 35°N, west of 40°W) and force 3 to 4 south of 40°N (south of 35°N, west of 40°W).

GALES (force 8 or higher) tend to decrease in strength and frequency during the latter half of March. On the average, gale-force winds have been noted in 10 percent of the ship observations north of a line extending roughly from Cape Hatteras to the Bay of Biscay, excluding the southern Norwegian Sea, the waters south of western Iceland down to 60°N, the seas west of southern Ireland to about 33°W, and the waters east of Newfoundland. A small area of gale frequencies greater than 10 percent covers the Gulf of Lions. The maximum frequency of gale occurrence, 20 percent, may be expected from the southern tip of Greenland south to about 55°N and between 40° and 50°W.

EXTRATROPICAL CYCLONES. Principal storm tracks head from the Great Lakes and the Carolina coast to Newfoundland. From Newfoundland, a primary track curves northward to the west coast of southern Greenland, and another track runs northeastward to Iceland and then into the Barents Sea. Over the Mediterranean area, a primary track extends from the Bay of Biscay east-southeastward to the southern Turkish coast.

TROPICAL CYCLONES. Only one tropical storm, a hurricane in the Lesser Antilles in 1908, has been reported in the North Atlantic in the past 102 yr.

SEA HEIGHTS of 12 ft or more are encountered more than 10 percent of the time north of a line from about 150 mi east of Cape Hatteras to Brest, France; in a small area northwest of Barranquilla, Colombia; in the Strait of Otranto between Italy and Albania; and from the coast of Sardinia northwestward to France. A large irregularly shaped area of 20-percent frequency lies in the open ocean bounded roughly by the following coordinates: 60°N, 55°W; 68°N, 25°W; 60°N, 10°W; 43°N, 43°W. Smaller areas of 20-percent frequency lie northeast of Bermuda, west of central Norway, and in the Gulf of Lions.

VISIBILITY less than 2 mi occurs 10 percent or more of the time over a 400-mi-wide elliptically shaped area extending northeast-southwest from 55°N, 40°W to 42°N, 58°W; over an area of the Labrador Sea from Cape Mercy to Cod Island; over the North Sea from southern Norway southeastward to Denmark and Sweden; and north of a line extending from southern Greenland to north of Iceland and then to the Barents Sea.

NORTH PACIFIC, MARCH

WEATHER. March is normally considered one of the transitional months between winter and spring over the North Pacific. Compared to the North Atlantic, weather improvement is somewhat delayed by the vast expanse of the ocean and the lingering winter climate over Siberia. Stormy weather is about as frequent as in the preceding month along the northern routes, especially from the western Aleutians southwestward to the vicinity of Japan. The 1005-mb Aleutian Low lies about 250 mi south of the Komandorskiye Islands and the Pacific High (1022 mb) rests near 33°N, 144°W.

WINDS. From about 40° to 60°N, winds from the westerly quarter are most frequent, although winds are variable north of the Aleutians and easterly over the Gulf of Alaska. In 40 to more than 60 percent of the observations, the wind force is 4 to 6. However, near the North America coast the most frequent wind speeds are force 4 to 5. West to north winds are most prevalent in Japanese waters south of 40°N where more than 50 percent of all winds vary between force 4 and 6. During March, the northeast monsoon continues to prevail along the Asiatic coast south of Shanghai and over Philippine waters. From 25° to 40°N, wind directions are variable, and the force is from 3 to 5 more than 50 percent of the time. The "northeast trades" are the dominant winds from 25°N to the Equator and extend northward to about 30°N over the eastern part of the ocean. The usual wind speeds, force 3 to 5, persist more than 60 percent of the time over the ocean area under the influence of the trades. Northerly force 2 to 3 winds blow 40 percent of the time over the Mexican waters out from the Gulf of Tehuantepec.

GALES. In the central and western North Pacific, gales may be expected as far south as 30°N. In this area, north of 35°N and west of 175°W, 10 to more than 20 percent of ship reports contain winds of force 8 or higher. Over the eastern part of the ocean east of 175°W, there is a large reduction in gale frequencies compared to February, and occurrences are generally confined to latitudes north of 35°N. Percentage frequencies of gales in the central Gulf of Alaska, 10 to 20 percent in the preceding month, drop to 5 to 10 percent during March. Gales over the Gulf of Tehuantepec may be expected more than 5 percent but less than 10 percent of the time.

EXTRATROPICAL CYCLONES. The greatest frequency of cyclogenesis in the Northern Hemisphere takes place in the area off the Ryukyus in March. These storms run northeastward to an area about 250 mi east of Hokkaido where they join another primary track coming from La Perouse Strait between Sakhalin and Hokkaido. East of Hokkaido, the primary paths head northeastward to the western Aleutians where they either continue into the eastern Bering Sea or curve to the east-northeast and parallel the Aleutians and Alaska Peninsula until reaching the Gulf of Alaska. Another track extends from 50°N, 160°W, to the Gulf of Alaska. A storm track heads east-southeastward from the Gulf of Alaska to the Alaska Panhandle.

TROPICAL CYCLONES are infrequent during March. A tropical storm can be looked for once every 2 yr over the western ocean. Half of these tropical storms develop further into typhoons. Tropical cyclones during March usually sprout up east of the central and southern Philippines and west of 170°W.

SEA HEIGHTS of at least 12 ft occur more than

10 percent of the time in a somewhat rectangular area bounded approximately by 50°N and 33°N, and 155°E and 140°W.

VISIBILITY. The southern limit of 10-percent frequency of low visibility (less than 2 mi) extends from Mys Alevina, Siberia, southward to 42°N, 160°E, and then northeastward to west of Kodiak Island. This frequency increases to more than 20 percent from the waters around the northern Kurils northeastward to the Komandorskiye Islands and then northwestward to Mys Ozernoy.

NORTH ATLANTIC, APRIL

WEATHER. During April, weather conditions over the middle and northern latitudes are generally much more settled compared to the preceding month. Thus, intervals of favorable weather are more frequent and usually of longer duration. There is a notable reduction in the frequency and intensity of winter-type LOWS. The 1007-mb Icelandic Low lies off Kap Farvel near 59°N, 41°W. The Azores High (1021 mb) is centered more than 1,700 mi farther south near 30°N.

WINDS. The prevailing wind north of 40°N is generally from the westerly quarter of the compass except over the Norwegian Sea where winds are quite variable. Within this large belt, about 55 percent of the observations report winds of force 4 to 6. From about 40°N southward to the northern boundary of the trades, the prevailing wind continues to be mostly southwesterly as it was in March, although winds with an easterly component are prevalent off the east coast of Florida out to 70°W and over the Gulf of Mexico. Near the coasts of Morocco and Portugal, northerly winds continue to dominate, and westerly and northwesterly winds continue to hold sway over the Mediterranean Sea. The winds north of the trades and south of the westerlies are weaker than their counterparts north of 40°N--only about 45 percent of all observations yield winds of force 4 to 6. The trades are more firmly entrenched in April as compared to March. They usually prevail south of 25°N and in the eastern North Atlantic extend to about 30°N. Fifty to 75 percent of the time they are of force 3 to 4.

GALES. The area subject to gales compared to March decreases greatly in the middle and northern latitudes. The southern boundary of the 10-percent frequency of gales had moved from 40°N in March to 53°N in April. The gale area extends northward to about 65°N between 15° and 55°W. A small area (about 6° square) of 10-percent frequency is centered east of the Grand Banks near 47°N, 38°W. Gales also spread over the Gulf of Lions about 10 percent of the time.

EXTRATROPICAL CYCLONES. Principal areas of cyclogenesis during the spring months (March, April, and May) are found in a broad area from Cape May down to Georgia on the U.S. East Coast east-northeastward to the central ocean, including the waters around Newfoundland. Within this region cyclogenesis is concentrated from the coast of Virginia and North Carolina northeastward to a point near 39°N, 66°W. Other principal areas of cyclogenesis lie around the south coast of Iceland; over most of the Baltic Sea, including Danish waters but not including the Gulf of Bothnia; off Norway's arctic coast; over the Bay of Biscay; and over the Gulf of Genoa, the northern and central Adriatic Sea, and the southwestern Black Sea. Primary storm tracks in April are much the same as in March. One track begins about 250 mi east of Cape May and travels northeastward over the Grand Banks. The storms heading northeastward across the North Atlantic tend to pass a little farther south of Iceland than in March. Over the Mediterranean, the primary storm track reaches northern Italy, but does not extend to southern Turkey as it did in March.

TROPICAL CYCLONES have not been reported during April in the North Atlantic in the past 102 yr. This is the only month of the year in which no tropical storm activity has occurred.

SEA HEIGHTS of at least 12 ft are found more than 10 percent of the time north of a line extending from Labrador around the eastern margin of the Grand Banks to 41°N, 50°W, westward to 70°W. The same line curves eastward along the 36th parallel to 60°W and then across the North Atlantic to Ireland and central Norway. Another small area of 10-percent frequency extends from the Gulf of Lions southeastward to a distance of 150 mi out over the Mediterranean. An elliptically shaped area of 20-percent frequency extends from latitude 55° to 60°N and across longitudes 15° to 55°W.

VISIBILITY. Occurrences of low visibility increase over the western part of the North Atlantic, especially west of 40°W. The greatest change from March takes place over the Grand Banks and the waters south and east of Newfoundland where over 20 percent of the observations show visibilities of less than 2 mi. Visibility over the Norwegian Sea has decreased in the west and increased in the east. The area of 10-percent frequency of low visibility over the North Sea has moved southwestward and extends from the tip of southern Norway to the coast of Great Britain.

NORTH PACIFIC, APRIL

WEATHER. The weather over the North Pacific generally shows marked improvement over that of any month since October. Compared to the winter months, periods of storminess are fewer, but severe extratropical LOWS are still encountered occasionally. The Aleutian Low has broken down into an elongated 1009-mb trough stretching from east of Kamchatka to the Alaska Peninsula. The 1023-mb Pacific High rests near 32°N, 159°W.

WINDS. Over about half of the North Pacific between 40° and 55°N, the wind speeds are of force 4 to 6 in 50 to 65 percent of the observations. The remainder of this latitudinal belt, especially near the coast of North America, experiences winds of force 3 to 5. The prevailing winds are from the westerly quarter. Between 30° and 40°N, winds are variable west of 170°E, mainly southwesterly between 170°E and 150°W, and westerly to northerly east of 150°W. Forces 3 to 5 are recorded in 45 to 70 percent of the observations. Variable force 5 winds often blow over the western half of the Bering Sea, and northerly

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Environmental Data Service
WASHINGTON, D.C.

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
210

force 4 winds are quite common over the eastern half. Easterly winds of about force 4 sweep over the Gulf of Alaska. South of Japan, easterly force 4 winds prevail, and winds from any direction except west and southwest are common over the East China Sea where force 3 to 4 is the rule. The "northeast trades" prevail south of 25° N. over the western ocean between the dateline and the Philippines and south of 30°N over eastern waters. The trades blow at about force 4 except near the Equator and over the Philippine Sea where force 3 winds prevail. The northeast monsoon continues to dominate the South China Sea but with less strength and steadiness than in the colder months. Winds of force 2 to 3 account for between 46 and 63 percent of all observations. Northerly winds continue to prevail south of the Gulf of Tehuantepec, but gales over the Gulf now occur less than 5 percent of the time. Force 2 to 3 winds are experienced 50 percent of the time compared to 40 percent in March.

GALES. Two areas of high-gale frequencies, 10 to almost 20 percent, persist as a residual of the winter months in the middle and northern latitudes. One holds sway over the Gulf of Alaska south of Kodiak Island to about 53°N, and eastward to near 140°W. The other lies east of Honshu from about 36°N, 147°E, northeastward to about 45° to 48°N, and 178°E.

EXTRATROPICAL CYCLONES. Principal areas of cyclogenesis during the spring months include a large area stretching from south of Hokkaido and the southern Kurils to Taiwan and east-northeastward from the coast of mainland China near Shanghai to nearly 160° E. Most of the Yellow Sea and the extreme western portion of the Sea of Japan are not included within this vast region. Cyclogenesis is even more concentrated from the East China Sea across the Ryukyus to the waters well east of Honshu. Smaller areas of cyclogenesis exist over the eastern Aleutians and the Pribilofs, over the Gulf of Alaska, over an area from the Queen Charlotte Islands to Vancouver Island, and over a section of the east-central North Pacific about midway between the Hawaiian Islands and the eastern Aleutians. While the mean positions of storm tracks during April closely approximate those of the preceding month, there is a northward displacement near Japan and the Kuril Islands. This generally results in fewer gales and better weather over trans-Pacific routes. There is also a decrease in the number of storms that cross the Alaska Panhandle.

TROPICAL CYCLONES. In an average 7-yr period, about five tropical storms can be expected over Far Eastern waters. Almost all of these, about 85 percent, have developed to typhoon strength. Tropical cyclones develop in the same region as they did in March, but the area affected by these warm-core storms has expanded northwestward to include the waters east of Luzon and around Taiwan. A tropical cyclone in the eastern North Pacific in April would be a rarity.

SEA HEIGHTS. The area in which there is at least a 10-percent frequency of 12 ft or higher seas has decreased in size since March. This area now extends eastward only to 150°W. The southern boundary in the eastern portion is 42°N, while the northern and western extent of this area of 10-percent frequency remains similar to that of March.

VISIBILITY. Reduced visibility (less than 2 mi) of 10-percent or greater frequency extends to the north of a line drawn from Sakhalin southeastward to about 40°N, 160°E, and then east-northeastward to about 45°N, 175°W. From there the line swings northward to Amlia Island in the eastern Aleutians and then eastward to about 50°N, 150°W, before cutting back across the Alaska Peninsula to the Bering Sea, east of St. Lawrence Island. The area of 20-percent frequency has decreased in size since March and is now centered over the northern Kurils.

THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.